Coimisiún na Scrúduithe Stáit
State Examinations Commission

Leaving Certificate 2021

Marking Scheme

Mathematics

Ordinary 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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Paper 1

Marking Scheme – Paper 1, Section A and Section B

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	E
No of categories	2	3	4	5	6
5 mark scales	0, 5	0, 2, 5	0, 2, 3, 5	0, 2, 3, 4, 5	
10 mark scales	0, 10	0, 5, 10	0, 3, 7, 10	0, 3, 5, 8, 10	
15 mark scales	0, 15	0, 7, 15	0, 5, 10, 15	0, 4, 7, 11, 15	
20 mark scales	0, 20	0, 10, 20	0, 7, 13, 20	0, 5, 10, 15, 20	
25 mark scales	0, 25	0, 12, 25	0, 8, 17, 25	0, 6, 12, 19, 25	0, 5, 10, 15, 20, 25

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
- correct response

B-scales (three categories)

- response of no substantial merit
- partially correct response
- correct response

C-scales (four categories)

- response of no substantial merit
- response with some merit
- almost correct response
- correct response

D-scales (five categories)

- response of no substantial merit
- response with some merit
- response about half-right
- almost correct response
- correct response

E-scales (six categories)

- response of no substantial merit
- response with some merit
- response almost half-right
- response more than half-right
- almost correct response
- correct response

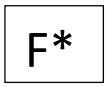
In certain cases, typically involving incorrect rounding, omission of units, a misreading that does not oversimplify the work or an arithmetical error that does not oversimplify the work, a mark that is one mark below the full-credit mark may also be awarded. Thus, for example, in *scale 10C*, 9 marks may be awarded.
Throughout the scheme indicate by use of ***** where an arithmetic error occurs.

Summary of mark allocations and scales to be applied

Section A	
Question 1	**(30 marks)**
(a)	**5C**
(b)	**5C**
(c)	**10C**
(d)	**10C**
Question 2	**(30 marks)**
(a)	**10D**
(b)	**10C**
(c)	**10D**
Question 3	**(30 marks)**
(a)	**10C**
(b)	**10D**
(c)	**10C**
Question 4	**(30 marks)**
(a)	**10C**
(b)	**20D**
Question 5	**(30 marks)**
(a)	**10C**
(b)	**10C**
(c)	**10D**
Question 6	**(30 marks)**
(a)(i)	**5C**
(a)(ii)	**5C**
(a)(iii)	**10C**
(b)	**10C**

Section B	
Question 7	**(50 marks)**
(a)	**5C**
(b)	**10D**
(c)	**10D**
(d)	**10D**
(e)	**15D**
Question 8	**(50 marks)**
(a)	**5C**
(b)	**10D**
(c)	**5B**
(d)+(e)	**20D**
(f)	**10D**
Question 9	**(50 marks)**
(a)(i)	**5C**
(a)(ii)	**5C**
(a)(iii)	**5C**
(a)(iv)	**10D**
(a)(v)	**5C**
(a)(vi)	**5C**
(b)(i)	**5C**
(b)(ii)	**10C**
Question 10	**(50 marks)**
(a)(i)	**10C**
(a)(ii)	**10D**
(b)(i)	**10D**
(b)(ii)	**10D**
(b)(iii)	**10D**

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 or Unit or Arithmetic error Misreading	
	Horizontal wavy	Error	
	Tick L		The work presented in the body of the script merits low partial credit
	Tick M		The work presented in the body of the script merits mid partial credit (or partial credit)
	Tick 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	

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

e.g. In a **C scale** where * and  and  appear in the body of the work then  should be placed in the right margin.

In the case of a **D scale** with the same level of annotation then  should be placed in the right margin.

A  in the body of the work may sometimes be used to indicate where a portion of the work presented has value and has merited one of the levels of credit described in the marking scheme.
The level of credit is them indicated in the right margin.

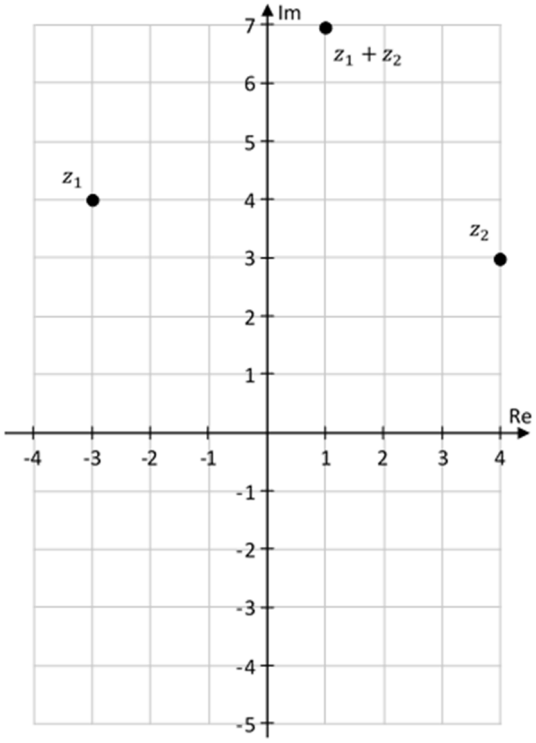
Model Solutions & Detailed Marking Notes

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.

Section A

Q1	Model Solution – 30 Marks	Marking Notes
(a)	$\frac{380}{100} \times 121 = €459{\cdot}8$	**Scale 5C (0, 2, 3, 5)** *Low Partial Credit:* • 380×21 or 7980 • 380×121 and stops • Any use of relevant % *High Partial Credit:* • $380 \times 21\%$ = 79·80 • $380 \times 121 = 45980$ **Note**: Accept correct answer without supporting work
(b)	$\frac{130{\cdot}2}{21} \times 121 = €750{\cdot}20$	**Scale 5C (0, 2, 3, 5)** *Low Partial Credit:* • $\frac{130{\cdot}2}{21}$ and stops • $130{\cdot}2 \times 121$ and stops • Any use of relevant % *High Partial Credit:* • $\frac{130{\cdot}2}{21}$ = 6·2 • $130{\cdot}2 \times 121\%$= 157·54 • €620 **Note**: Accept correct answer without supporting work

(c)	$\frac{290{\cdot}4}{121} \times 21 = €50{\cdot}40$	**Scale 10C (0, 3, 7, 10)** *Low Partial Credit:* • $290{\cdot}4 \times 21$ • $\frac{290{\cdot}4}{121}$ and stops • Any use of relevant % *High Partial Credit:* • $\frac{290{\cdot}4}{121} = 2{\cdot}4$ • $290{\cdot}4 \times 21\% = 60{\cdot}984$ **Note**: Accept correct answer without supporting work
(d)	$\frac{336}{2} \times 100 = €16\,800$ $\frac{16800}{30} = €560$ for one computer	**Scale 10C (0, 3, 7, 10)** *Low Partial Credit:* • 2% • Use of 336 • Finds €11·20 • Any use of relevant % *High Partial Credit:* • $€16\,800$ • 5·6 • €1120 **Note**: Accept correct answer without supporting work

Q2	Model Solution – 30 Marks	Marking Notes
(a)	$z_1 + z_2 = 1 + 7i$ (diagram below)  	**Scale 10D (0, 3, 5, 8, 10)** **Note:** 5 items: ($z_1 + z_2$ calculated, 3 plots, all plots labelled) *Low Partial Credit:* • One correct item • Substitutes for z_1 and / or z_2 *Mid Partial Credit:* • Two correct items, with or without labels *High Partial Credit:* • Three correct items
(b)	$$\frac{(-3+4i)(4-3i)}{(4+3i)(4-3i)} =$$ $$\frac{0+25i}{25}$$ $= 0 + \frac{25}{25}i$ or $0 + i$ or $\frac{25}{25}i$ or i	**Scale 10C (0, 3, 7, 10)** *Low Partial Credit:* • Some correct substitution • Conjugate identified • Some multiplication above and below by same number, even if incorrect conjugate *High Partial Credit:* • $\frac{(-3+4i)(4-3i)}{(4+3i)(4-3i)}$

(c)	$\bar{z}_1 = -3 - 4i$ $\bar{z}_1 - z_2 = -3 - 4i - (4 + 3i)$ $\bar{z}_1 - z_2 = -3 - 4i - 4 - 3i$ $= -7 - 7i$ $\lvert\bar{z}_1 - z_2\rvert = \sqrt{(-7)^2 + (-7)^2}$ $= \sqrt{49 + 49}$ $= \sqrt{98}$ $= 7\sqrt{2}$	**Scale 10D (0, 3, 5, 8, 10)** *Low Partial Credit:* • Work of relevance for $\bar{z}_1 - z_2$ • $\sqrt{a^2 + b^2}$ *Mid Partial Credit:* • $\bar{z}_1 - z_2 = -7 - 7i$ *High Partial Credit:* • $\sqrt{(-7)^2 + (-7)^2}$ or $\sqrt{49 + 49}$ **Note**: Accept $\sqrt{98}$ for full credit

Q3	Model Solution – 30 Marks	Marking Notes
(a)	$4^2 - 2(4) - 8 = 16 - 16 = 0$	**Scale 10C (0, 3, 7, 10)** *Low Partial Credit:* • Any partial substitution into equation • $f(4)$ or equivalent written • Quadratic formula written • Attempt at factorising • $(x - 4)$ *High Partial Credit:* • $f(4)$ fully substituted and not equated to 0 • $(x - 4)$ and $(x + 2)$ • Quadratic formula fully substituted
(b)	$f(5) = 25 + 5a + b = 0$ $f(-2) = 4 - 2a + b = 0$ $5a + b = -25$ $2a - b = 4$ $7a = -21$ $a = -3$ $\Rightarrow b = -10$ **or** $(x - 5)(x + 2) = 0$ $x^2 - 3x - 10 = 0$ $a = -3 \Rightarrow b = -10$	**Scale 10D (0, 3, 5, 8, 10)** *Low Partial Credit:* • $f(5)$ • $f(-2)$ • Any relevant equation in a and b (without x) • Either factor • Mention of Sum and/or Product of Roots mentioned *Mid Partial Credit:* • Both equations in a and b • Both factors • Sum **or** Product of roots found *High Partial Credit:* • a or b found • $x^2 - 3x - 10$ without further relevant work • Sum **and** Product of roots found
(c)	$\frac{2 \pm \sqrt{(-2)^2 - 4(5)(-9)}}{(2)(5)}$ $= \frac{2 \pm \sqrt{184}}{10}$ $x = 1{\cdot}56$ or $x = -1{\cdot}16$	**Scale 10C (0, 3, 7, 10)** *Low Partial Credit:* • Correct quadratic formula • *a* or *b* or *c* explicitly identified • Correct answer without work *High Partial Credit:* • Fully correct substitution into formula

Q4	Model Solution – 30 Marks	Marking Notes
(a)	$8x + 12 - 7 = 3x - 15$ $5x = -20$ $x = -4$	**Scale 10C (0, 3, 7, 10)** *Low Partial Credit:* • Any correct multiplication into a bracket • Any correct transposition • Correct answer without supporting work *High Partial Credit:* • Multiplication fully correct
(b)	$y = 2x - 7$ $x^2 + 4x^2 - 28x + 49 - 49 = 0$ $5x^2 - 28x = 0$ $x(5x - 28) = 0$ $x = 0$ or $x = \frac{28}{5}$ $y = -7$ or $y = \frac{21}{5}$	**Scale 20D (0, 5, 10, 15, 20)** *Low Partial Credit:* • x or y isolated • Quadratic formula written • Any correct transposing *Mid Partial Credit:* • $x^2 + (2x - 7)^2 = 49$ or equivalent equation in one variable *High Partial Credit:* • 1 relevant value (root) found from quadratic

Q5	Model Solution – 30 Marks	Marking Notes
(a)	$3(0{\cdot}67)^2 - 6(0{\cdot}67) + 7$ $= 4{\cdot}3267$ $= 4{\cdot}33$	**Scale 10C (0, 3, 7, 10)** *Low Partial Credit:* • Any substitution into equation • $x = 0{\cdot}67$ *High Partial Credit:* • $f(0{\cdot}67)$ fully substituted **Note:** • Accept correct answer (4·33) without supporting work • $4{\cdot}3267$ without supporting work merits F*
(b)	$3x^2 - 6x + 7 = 4$ $3x^2 - 6x + 3 = 0$ $3(x-1)(x-1) = 0$ $\Rightarrow \ x = 1$	**Scale 10C (0, 3, 7, 10)** *Low Partial Credit:* • $3x^2 - 6x + 7 = 4$ • $3x^2 - 6x + 3 = 0$ • Correct quadratic formula • *a* or *b* or *c* explicitly identified • $x = 4$ substituted into the equation • Correct answer without supporting work *High Partial Credit:* • Correct factors • Fully correct substitution into formula

(c)	$6x - 6 = 0$ $x = 1$ $f(1) = 3 - 6 + 7 = 4$ Min Point $= (1, 4)$	**Scale 10D (0, 3, 5, 8, 10)** **Note:** If differentiation is not used, award zero marks *Low Partial Credit:* • Any correct differentiation • $\frac{dy}{dx} = 0$ or $\frac{dy}{dx}$ or $f'(x)$ *Mid Partial Credit:* • $6x - 6$ *High Partial Credit:* • x co-ordinate found

Q6	Model Solution – 30 Marks	Marking Notes
(a) (i)	$T_2 - T_1 = T_3 - T_2$ $k + 5 = 1 - k$ $2k = -4$ $k = -2$ --- $-\mathbf{5}\ add\ 3, -\mathbf{2}\ add\ 3\ ,\ \ \mathbf{1}$ or $-\mathbf{5} + 3 = -2$ and $-\mathbf{2} + 3 = \mathbf{1}$	**Scale 5C (0, 2, 3, 5)** *Low Partial Credit:* • T_n formula written • Some relevant substitution into formula • $a = -5$ • $-5 + 3 + 3 = 1$ • If you see the number 6 *High Partial Credit:* • $k = -2$ and stops • Relevant equation in k and common difference $= 3$ shown • $2d = 6$ **Note**: Common difference must be explicitly shown to be 3
(a) (ii)	$T_{10} = -5 + (9)3 = 22$ or $-5, -2, 1, 4, 7, 10, 13, 16, 19, 22$ $T_{10} = 22$	**Scale 5C (0, 2, 3, 5)** *Low Partial Credit:* • Some relevant substitution into T_n formula • T_n formula written • List containing 4 correct terms or more • *a* and/or *d* identified *High Partial Credit:* • Formula fully substituted • List with more than 10 terms but $T_{10} = 22$ not clearly identified **Note**: Accept correct answer without supporting work

(a) (iii)	$-5 + 3(n-1) = 247$ $3n = 255$ $n = 85$	**Scale 10C (0, 3, 7, 10)** *Low Partial Credit:* • Some relevant substitution into T_n formula • $T_n = 247$ • a and/or d identified • T_n formula written • T_{247} • List method containing at least 4 terms *High Partial Credit:* • T_n formula fully substituted and = 247 **Note**: Accept correct answer without supporting work
(b)	$a = 4, \quad d = 5$ $S_{50} = \frac{50}{2}[2(4) + (50-1)5]$ $= 6325$	**Scale 10C (0, 3, 7, 10)** *Low Partial Credit:* • Some relevant substitution into S_n formula • S_n formula written • a or d explicitly identified • At least 4 terms listed *High Partial Credit:* • Formula fully substituted **Note**: Accept correct answer without supporting work

Section B

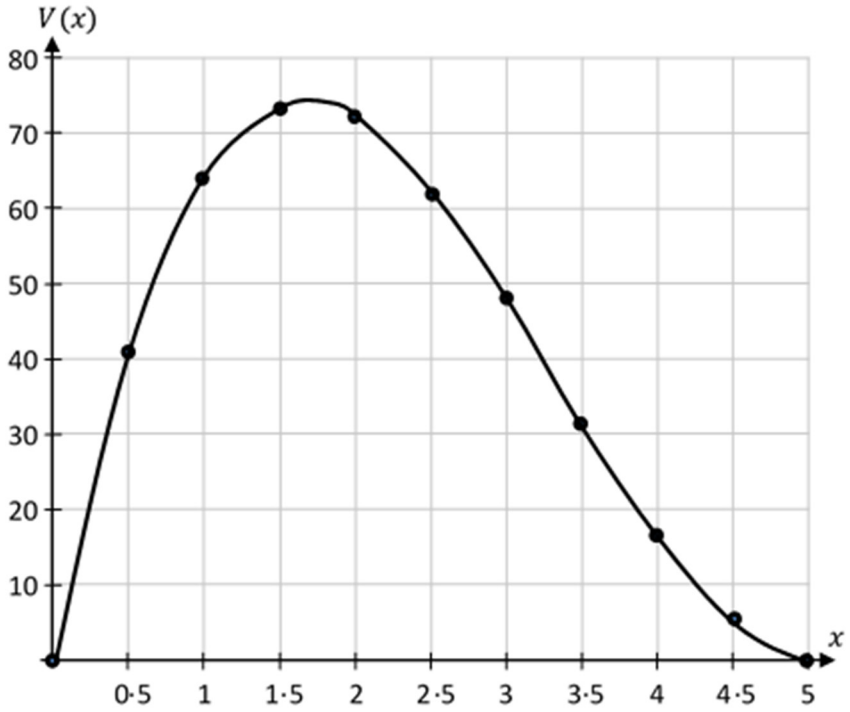
Q7	Model Solution – 50 Marks	Marking Notes
(a)	€12 012 + €8472 + €49 560 = $€70{,}044$	**Scale 5C (0, 2, 3, 5)** *Low Partial Credit:* • Any 2 of €12012 or €8472 or €49560 written or added *High Partial Credit:* • Addition of 3 terms formulated **Note**: Accept correct answer without supporting work
(b)	0·5% of 12012 $= 60{\cdot}06$ 2% of $8472 = 169{\cdot}44$ $4{\cdot}5\%$ of $49560 = 2230{\cdot}20$ Total = $€2459{\cdot}70$	**Scale 10D (0, 3, 5, 8, 10)** *Low Partial Credit* • Any correct formulation of any USC rate (e.g. 0·5% of 12012 or $60{\cdot}06$) • Any use of relevant % *Mid Partial Credit:* • Correct formulation of any 2 USC rates *High Partial Credit:* • Correct formulation of all 3 USC rates
(c)	0·5% of 12012 $= 60{\cdot}06$ 2% of $8472 = 169{\cdot}44$ 54800 – (12012 + 8472) = 34316 $4{\cdot}5\%$ of $34316 = 1544{\cdot}22$ Total = $€1773{\cdot}72$	**Scale 10D (0, 3, 5, 8, 10)** *Low Partial Credit:* • $60{\cdot}06$ or $169{\cdot}44$ transferred from above • 34316 found • Any use of relevant % • 20 484 found *Mid Partial Credit:* • $4{\cdot}5\%$ of 34316 *High Partial Credit:* • Correct formulation of all 3 USC rates

(d)	$1602{\cdot}72 - [60{\cdot}06 + 169{\cdot}44] =$ $1373{\cdot}22$ $\frac{1373{\cdot}22}{4{\cdot}5} \times 100 = 30516$ $30516 + 12012 + 8472$ $= €51{,}000$	**Scale 10D (0, 3, 5, 8, 10)** *Low Partial Credit:* • $60{\cdot}06$ or $169{\cdot}44$ transferred from above • Any use of relevant % *Mid Partial Credit:* • $1373{\cdot}22$ *High Partial Credit:* • $30\,516$
(e)	Top rate USC $= 3496{\cdot}18 - (2459{\cdot}70) = 1036{\cdot}48$ $83000 - 70044 = 12956$ $\frac{1036{\cdot}48}{12956} \times 100 = 8\%$	**Scale 15D (0, 4, 7, 11, 15)** *Low Partial Credit:* • $2459{\cdot}70$ transferred from above • $70\,044$ transferred from above • Relevant figures transferred from section (a) and / or (b) • Correct answer without supporting work *Mid Partial Credit:* • $(3496{\cdot}18 - 2459{\cdot}70)$ or $1036{\cdot}48$ • $(83000 - 70044)$ or 12956 *High Partial Credit:* • $1036{\cdot}48$ and 12956

Q8	Model Solution – 50 Marks	Marking Notes
(a)	$l = (10 - 2x)$, $b = (10 - 2x)$, $h = x$	**Scale 5C (0, 2, 3, 5)** *Low Partial Credit:* • One correct dimension explicitly formulated *High Partial Credit:* • Two correct dimensions given
(b)	$V = (10 - 2x)(10 - 2x)x$ $V = x(100 - 40x + 4x^2)$ $V = 100x - 40x^2 + 4x^3$	**Scale 10D (0, 3, 5, 8, 10)** *Low Partial Credit:* • Correct Volume formula written • Some relevant substitution into volume formula • l or b or h explicitly identified *Mid Partial Credit:* • Formula fully substituted *High Partial Credit:* • Formula fully substituted with 2 or more correct multiplications
(c)	Width is $(10 - 2x)$ therefore if x is 6 (greater than 5), then $2x$ is greater than 10 resulting in a negative width	**Scale 5B (0, 2, 5)** *Partial Credit:* • Partial explanation

(d) + (e)

x (m)	0	0·5	1	1·5	2	2·5	3	3·5	4	4·5	5
$V(x)$ (m^3)	0	**40·5**	64	73·5	72	62·5	48	31·5	16	**4·5**	0



Scale 20D (0, 5, 10, 15, 20)

Note: 21 items (9 table entries, 11 plot points, 1 join points)

Low Partial Credit:

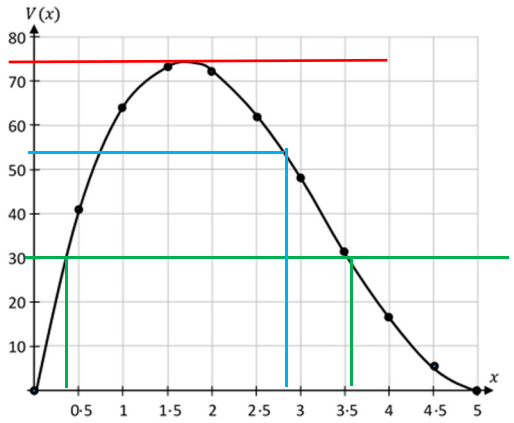
- 1 Item correct

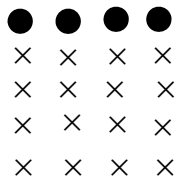
Mid Partial Credit:

- 9 Items correct

High Partial Credit:

- 15 items correct

(f) (i) + (ii) + (iii)	**(i)** 74 **(ii)** $x = 0{\cdot}35$ and $x = 3{\cdot}55$ **(iii)** 54  	**Scale 10D (0, 3, 5, 8, 10)** *Low Partial Credit:* • Relevant work • One part correct without work *Mid Partial Credit:* • One part correct with corresponding correct graph work • Two parts correct without complete graph work *High Partial Credit:* • Two parts correct with corresponding correct graph work • Three parts correct without complete graph work

Q9	Model Solution – 50 Marks	Marking Notes
(a) (i)	 4th Pattern	**Scale 5C (0, 2, 3, 5)** *Low Partial Credit:* • Correct number of rows • Correct number of columns *High Partial Credit:* • Correct number of dots • Correct number of crosses
(a) (ii)	$T_n = 1 + (n-1)1$ $T_n = n$	**Scale 5C (0, 2, 3, 5)** *Low Partial Credit:* • T_n formula written • *a* and/or *d* identified *High Partial Credit:* • Formula with some substitution **Note:** Accept correct answer without supporting work
(a) (iii)	$S_{20} = \frac{20}{2}[2(1) + (20-1)1]$ $= 210$	**Scale 5C (0, 2, 3, 5)** *Low Partial Credit:* • S_n formula written • S_n formula with some substitution • *a* and/or *d* identified • List of 4 terms or more (1, 2, 3, 4, …) *High Partial Credit:* • Formula fully substituted correctly • 20 terms listed with addition indicated (1 + 2 + 3 + 4 + … +20) **Note:** Accept correct answer without supporting work

<table>
<tr>
<td>(a)
(iv)</td>
<td>
<table>
<tr><td>Pattern</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td></tr>
<tr><td>Number</td><td>1</td><td>4</td><td>9</td><td>16</td><td>25</td><td>36</td></tr>
</table>

No of crosses $= n^2$
</td>
<td>Scale 10D (0, 3, 5, 8, 10)
Low Partial Credit:
• One or two correct table entries

Mid Partial Credit:
• Three correct table entries
• n^2 without table entries

High Partial Credit:
• Four correct table entries
• n^2 with any correct table entries</td>
</tr>
<tr>
<td>(a)
(v)</td>
<td>144</td>
<td>Scale 5C (0, 2, 3, 5)
Low Partial Credit:
• n^2 written
• List of 6 terms or more (1, 4, 9, 16, 25, 36,…)
• 49

High Partial Credit:
• 12^2
Note: Accept correct answer without supporting work</td>
</tr>
<tr>
<td>(a)
(vi)</td>
<td>$T_n(dots) + T_n(crosses) = n + n^2$

$T_{10} + T_{10}$

$10 + 10^2 = 110$

or

$T_{10} + T_{10} = 110$</td>
<td>Scale 5C (0, 2, 3, 5)
Low Partial Credit:
• $a + (n-1)d$ or n or n^2 written
• Some relevant substitution into T_n (dots)
• Dots and crosses explicitly identified
• One extra correct pattern

High Partial Credit:
• Formulas fully substituted

Note: Accept correct answer without supporting work</td>
</tr>
</table>

(b) **(i)**	$T_1 = \frac{1^2}{2} + b + c$ **or** $\frac{1}{2} + b + c$ $T_2 = \frac{2^2}{2} + 2b + c$ **or** $2 + 2b + c$	**Scale 5C (0, 2, 3, 5)** *Low Partial Credit:* • Any relevant substitution *High Partial Credit:* • One full substitution
(b) **(ii)**	$\frac{1}{2} + b + c = 1 \quad \Rightarrow \quad b + c = \frac{1}{2}$ $2 + 2b + c = 3 \quad \Rightarrow \quad 2b + c = 1$ $\Rightarrow \quad b = \frac{1}{2} \quad \Rightarrow \quad c = 0$	**Scale 10C (0, 3, 7, 10)** *Low Partial Credit:* • One or both equations from (b)(i) transferred *High Partial Credit:* • One variable found

Q10	Model Solution – 50 Marks	Marking Notes
(a) (i)	$\frac{10^9}{250000} = 4000$ seconds $= 66{\cdot}67$ minutes $= 67$ minutes	**Scale 10C (0, 3, 7, 10)** *Low Partial Credit:* • 10^9 or equivalent • $\frac{x}{250000}$ where $x \neq 10^9$ • Correct answer without supporting work • Divides by 1000 • Use of 60 *High Partial Credit:* • $\frac{10^9}{250000}$ or 4000
(a) (ii)	$250000 \times 1{\cdot}1$ $= 275000$ litres/sec $= 275$ m^3/sec $275 \times 60 \times 60 \times 24$ $= 23760000$ $= 2{\cdot}38 \times 10^7$	**Scale 10D (0, 3, 5, 8, 10)** *Low Partial Credit:* • $1{\cdot}1$ or 110% or 25000 or 250000 • Correct answer without supporting work *Mid Partial Credit:* • $250000 \times 110\%$ • 275000 *High Partial Credit:* • $275 \times 60 \times 60 \times 24$ or 23760000 **Note**: Award F* for $2{\cdot}376 \times 10^7$
(b) (i)	$D = 2\pi(0{\cdot}5) = 3{\cdot}14$ km $T = \frac{2\pi(0{\cdot}5)3}{6}$ $= 1{\cdot}5707$ hours or $1{\cdot}57$ $= 94{\cdot}2$ mins $= 94$ mins	**Scale 10D (0, 3, 5, 8, 10)** *Low Partial Credit:* • $2\pi r$ • $3{\cdot}14$ km without work • $T = \frac{D}{S}$ or equivalent • πr^2 with $r = 0{\cdot}5$ inserted • Correct answer without supporting work *Mid Partial Credit:* • $\frac{2\pi(0{\cdot}5)3}{6}$ • $9{\cdot}4247$ or $9{\cdot}42$ *High Partial Credit:* • $1{\cdot}5707$ hours or similar

(b) **(ii)**	$T = \frac{D}{S}$ $\Rightarrow T = \frac{3(1{\cdot}15^4)}{4} = \frac{5{\cdot}247}{4}$ $= 1{\cdot}3117$ hours $= 1$ hour and $18{\cdot}7$ mins $= 78{\cdot}7$ $= 79$ mins	**Scale 10D (0, 3, 5, 8, 10)** *Low Partial Credit:* • $1{\cdot}15$ or 115% • $3 \times 15\%$ • $3 \times 1{\cdot}15$ • $T = \frac{D}{S}$ or equivalent • Correct answer without supporting work *Mid Partial Credit:* • $\frac{3(1{\cdot}15^4)}{4}$ *High Partial Credit:* • $1{\cdot}3117$ hours or similar **Note:** • Award F* for $\frac{3(1{\cdot}15^5)}{4}$ finished correctly • Award F* for Early Round Off which impacts the answer

(b) (iii)	Both together walk 1 full circle. $D = S \times T$ $\Rightarrow 3{\cdot}14 = 10T$ $T = 0{\cdot}314$ hours For John: $D = 6 \times 0{\cdot}314 = 1{\cdot}88495$ km $D = 1884{\cdot}955$ m $= 1885$ m or J : M = 6 : 4 John will walk $\frac{6}{10}$ of path before they meet again. $D = 6 \times \frac{3{\cdot}14}{10} = 1885$ m Or Time for John is equivalent to Mary standing still and John walking full circle at 10 km/h. $T(\text{John}) = \frac{3{\cdot}14}{10} = 0{\cdot}314$ hours $D = 6 \times \frac{3{\cdot}14}{10} = 1885$ m	**Scale 10D (0, 3, 5, 8, 10)** *Low Partial Credit:* • $3{\cdot}14$ km or their length from (b)(i) • $D = S \times T$ or equivalent • Correct answer without supporting work *Mid Partial Credit:* • $\frac{6}{10}$ • $\frac{3{\cdot}14}{10}$ • $10T$ • 2·5 D *High Partial Credit:* • $T(\text{John}) = 0{\cdot}314$ hours • $T(\text{Mary}) = 0{\cdot}314$ hours • Mary's distance is 1256·6

Coimisiún na Scrúduithe Stáit
State Examinations Commission

Leaving Certificate 2021

Marking Scheme

Mathematics

Ordinary Level

Paper 2

Marking Scheme – Paper 2, Section A and Section B

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	E
No of categories	2	3	4	5	6
5 mark scales	0, 5	0, 2, 5	0, 2, 3, 5	0, 2, 3, 4, 5	
10 mark scales	0, 10	0, 5, 10	0, 3, 7, 10	0, 3, 5, 8, 10	
15 mark scales	0, 15	0, 7, 15	0, 5, 10, 15	0, 4, 7, 11, 15	
20 mark scales	0, 20	0, 10, 20	0, 7, 13, 20	0, 5, 10, 15, 20	
25 mark scales	0, 25	0, 12, 25	0, 8, 17, 25	0, 6, 12, 19, 25	0, 5, 10, 15, 20, 25

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
- correct response

B-scales (three categories)

- response of no substantial merit
- partially correct response
- correct response

C-scales (four categories)

- response of no substantial merit
- response with some merit
- almost correct response
- correct response

D-scales (five categories)

- response of no substantial merit
- response with some merit
- response about half-right
- almost correct response
- correct response

E-scales (six categories)

- response of no substantial merit
- response with some merit
- response almost half-right
- response more than half-right
- almost correct response
- correct response

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. Thus, for example, in *scale 10C*, 9 marks may be awarded.
Throughout the scheme indicate by use of ***** where an arithmetic error occurs.

Summary of mark allocations and scales to be applied

Section A

Question 1	**(30 marks)**
(a)	10C
(b)(i)	5C
(b)(ii)	5C
(c)(i)	5C
(c)(ii)	5C
Question 2	**(30 marks)**
(a)(i)	10C
(a)(ii)	10C
(b)	10D
Question 3	**(30 marks)**
(a)	10D
(b)(i)	10D
(b)(ii)	10C
Question 4	**(30 marks)**
(a)(i)	5C
(a)(ii)	5C
(a)(iii)	5C
(a)(iv)	10D
(b)	5D
Question 5	**(30 marks)**
(a)	10C
(b)(i)	10D
(b)(ii)	5B
(b)(iii)	5B
Question 6	**(30 marks)**
(a)(i)	5C
(a)(ii)	10D
(b)(i)	5B
(b)(ii)	10C

Section B

Question 7	**(50 marks)**
(a)(i)	15C
(a)(ii)	5C
(a)(iii)	5B
(a)(iv)	10C
(b)(i)	5C
(b)(ii)	5C
(b)(iii)	5C
Question 8	**(50 marks)**
(a)(i)	15D
(a)(ii)	5B
(b)(i)	5B
(b)(ii)	10D
(c)	15D
Question 9	**(50 marks)**
(a)(i)	10C
(a)(ii)	5B
(a)(iii)	10D
(b)(i)	15D
(b)(ii)	15D
Question 10	**(50 marks)**
(a)(i)	10B
(a)(ii)	5C
(b)(i)	10C
(b)(ii)	5D
(c)(i)	5C
(c)(ii)	5C
(c)(iii)	10C

Model Solutions & Detailed 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.

<table>
<tr><th>Q1</th><th>Model Solution – 30 Marks</th><th>Marking Notes</th></tr>
<tr><td>(a)</td><td>
<table>
<tr><td>RH Y</td><td>LH Y</td><td>RF Y</td><td>LF Y</td></tr>
<tr><td>RH R</td><td>LH R</td><td>RF R</td><td>LF R</td></tr>
<tr><td>RH G</td><td>LH G</td><td>RF G</td><td>LF G</td></tr>
<tr><td>RH B</td><td>LH B</td><td>RF B</td><td>LF B</td></tr>
</table>

or
$4 \times 4 = 16$
</td><td>
Scale 10C (0, 3, 7, 10)
Low Partial Credit:
Work of merit
• Any outcome listed
• 4 + 4

High Partial Credit:
Significant work
• 10 outcomes listed
• 4×4

Full Credit:
• Correct answer without supporting work

Zero Credit:
• Answer as a probability
</td></tr>
</table>

(b) **(i)**	$\frac{4}{16}$ or $\frac{1}{4}$	**Scale 5C (0, 2, 3, 5)** *Low Partial Credit:* Work of merit • One outcome with left foot listed • A valid #E or #S in fraction format with no work shown *High Partial Credit:* Significant work • All 4 relevant outcomes listed *Full Credit:* • Correct answer without supporting work *Zero Credit:* • Probability > 1, without work
(b) **(ii)**	$\frac{8}{16}$ or $\frac{1}{2}$ or $\frac{1}{4}+\frac{1}{4}=\frac{1}{2}$	**Scale 5C (0, 2, 3, 5)** *Low Partial Credit:* Work of merit • One outcome with red or yellow spot listed • A valid #E or #S in fraction format with no work shown *High Partial Credit:* Significant work • All 8 outcomes listed • $\frac{1}{4}+\frac{1}{4}$ *Full Credit:* • Correct answer without supporting work *Zero Credit:* • Probability > 1, without work

(c) **(i)**	$\frac{1}{16}$ or $\frac{1}{4} \times \frac{1}{4} = \frac{1}{16}$	**Scale 5C (0, 2, 3, 5)** *Low Partial Credit:* Work of merit • $\frac{1}{4}$ • A valid #E or #S in fraction format with no work shown *High Partial Credit:* Significant work • $\frac{1}{4} \times \frac{1}{4}$ *Full Credit:* • Correct answer without supporting work *Zero Credit:* • Probability > 1, without work
(c) **(ii)**	$\frac{7}{16}$ or $\frac{4}{16} + \frac{4}{16} - \frac{1}{16} = \frac{7}{16}$	**Scale 5C (0, 2, 3, 5)** *Low Partial Credit:* Work of merit • One outcome with a right hand or a blue spot listed • $\frac{1}{4}$ • A valid #E or #S in fraction format with no work shown *High Partial Credit:* Significant work • All seven outcomes listed • $\frac{4}{16} + \frac{4}{16} = \frac{8}{16}$ *Full Credit:* • Correct answer without supporting work *Zero Credit:* • Probability > 1, without work

Q2	Model Solution – 30 Marks	Marking Notes
(a) (i)	$1 - 0{\cdot}34$ $= 0{\cdot}66$	**Scale 10C(0, 3, 7, 10)** *Low Partial Credit:* Work of merit • Mention of 1 *High Partial Credit* Significant work • Writes $1 - 0{\cdot}34$ *Full Credit:* • Correct answer without supporting work
(a) (ii)	$(0{\cdot}66)(0{\cdot}66)(0{\cdot}34)$ $= 0{\cdot}148104$ $= 0{\cdot}148$	**Scale 10C (0, 3, 7, 10)** *Low Partial Credit:* Work of merit • Fail, Fail, Success *High Partial Credit:* Significant work • Correct answer indicated but not calculated $(0{\cdot}66) \times (0{\cdot}66) \times (0{\cdot}34)$ *Full Credit:* • Correct answer without supporting work
(b)	$\lvert AC\rvert = \sqrt{(2)^2 + (2)^2} = \sqrt{8}$ Area $= \frac{1}{2}(2 \times 2) + \left(\sqrt{8} \times \sqrt{8}\right)$ $= 10$ cm^2 Perimeter $= 2 + 2 + 3\sqrt{8}$ $= 4 + 6\sqrt{2}$ $= 12{\cdot}48528 \ldots$ $= 12{\cdot}49$ cm	**Scale10D (0, 3, 5, 8, 10)** *Low Partial Credit:* Work of merit • Correct reference to/use of Pythagoras to calculate $\lvert AC\rvert$ *Mid Partial credit:* • Finds $\lvert AC\rvert$ *High Partial credit:* Significant work • Area or Perimeter correct • Expression for Area and Perimeter fully substituted but not calculated

Q3	Model Solution – 30 Marks	Marking Notes
(a)	$$\text{slope} = \frac{-2-2}{0-(-1)} = -4$$ $$y-2 = -4[x-(-1)]$$ $$y = -4x-4+2$$ $$y = -4x-2$$ or A: $\quad 2 = -m+c$ B: $\quad -2 = m(0)+c$ $\Rightarrow c = -2$ From A: $\quad 2 = -m-2$ $\Rightarrow m = -4$ $\rightarrow\ y = -4x-2$	**Scale 10D (0, 3, 5, 8, 10)** *Low Partial Credit:* Work of merit • Slope formula with some substitution *Mid Partial Credit:* • m found *High Partial Credit:* Significant Work • Eq. of line formula fully substituted • One error and finishes correctly • Answer not in required format or **Scale 10D (0, 3, 5, 8, 10)** *Low Partial Credit:* • Work of merit • Some correct substitution into equation $y = mx + c$ *Mid Partial Credit:* • Full substitution into both A & B • m or c found *High Partial Credit:* Significant Work • m and c found • One error and finishes correctly • Answer not in required format

(b) (i)

$$\text{slope of } l = \frac{3}{4}$$

$$\text{perpendicular slope} = \frac{-4}{3}$$

$$y - (-3) = \frac{-4}{3}(x - 6)$$

$$y + 3 = \frac{-4}{3}(x - 6)$$

$$k: 4x + 3y - 15 = 0$$

Scale10D (0, 3, 5, 8, 10)
Low Partial Credit:
Work of merit
- slope of $l = \frac{3}{4}$
- Eq. of line formula with some substitution

Mid Partial credit:
slope of $k = \frac{-4}{3}$

High Partial credit:
Significant Work
- Eq. of line formula fully substituted
- One error and finishes correctly
- Answer not in required format

(b) (ii)

$$\begin{array}{rl} l: & 3x - 4y = 5 \\ h: & \underline{-8x + 4y = -40} \\ & -5x = -35 \\ & x = 7 \end{array}$$

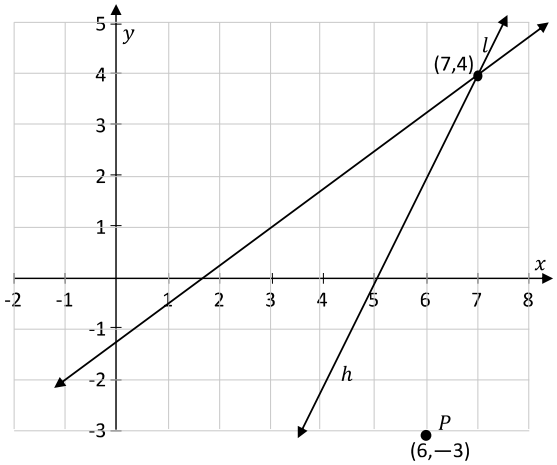
$$\Longrightarrow -8(7) + 4y = -40$$
$$4y = 56 - 40$$
$$4y = 16$$
$$y = 4$$

$$l \cap k = (7, 4)$$

or

Graphical Method

Line h: (5, 0), (6, 2) or (3, −4)



Scale 10C (0, 3, 7, 10)
Low Partial Credit:
Work of merit
- Effort to equate coefficients of x or y
- Effort at isolating one variable
- Effort at drawing line h
- Correct answer without work

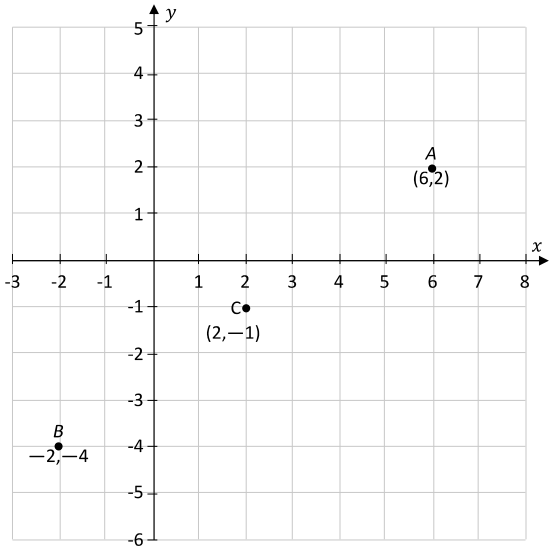
High Partial Credit:
Significant Work
- One variable found
- One error and finishes correctly

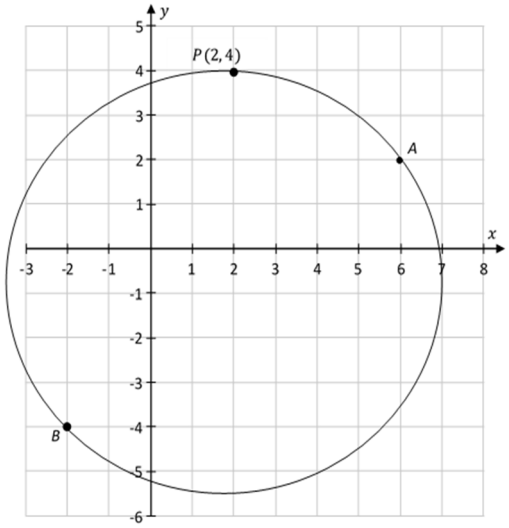
or

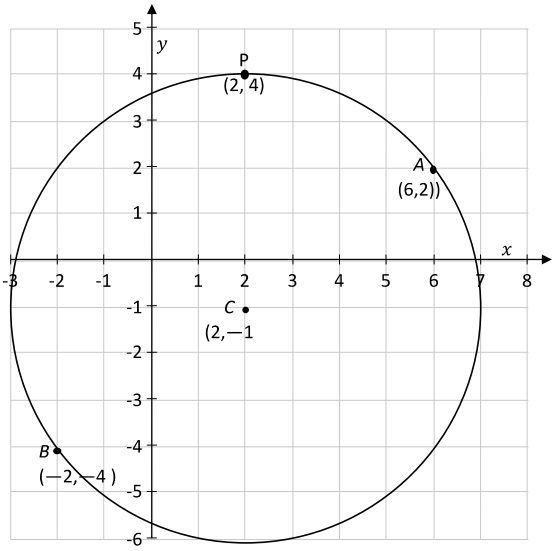
Scale 10C (0, 3, 7, 10)
Low Partial Credit:
Work of merit
- Finds one point on h

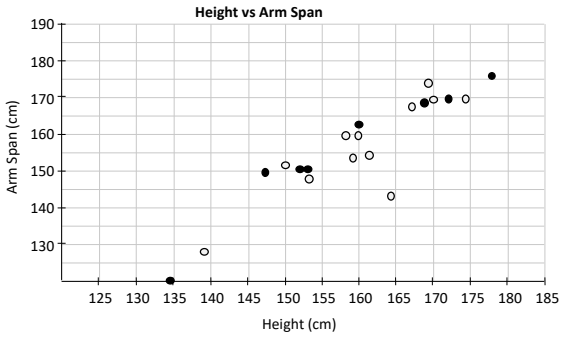
High Partial Credit:
Significant Work
- Draws h

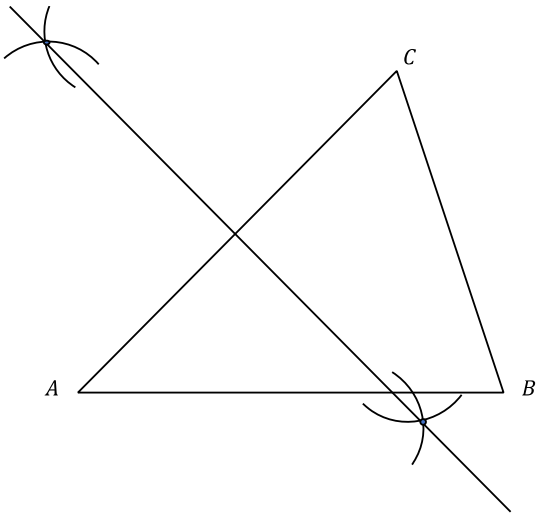
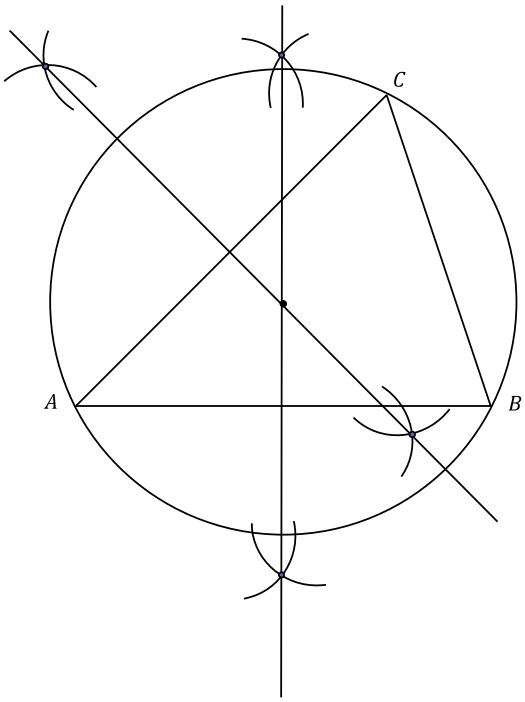
Full Credit:
- $l \cap k = (7, 4)$

Q4	Model Solution – 30 Marks	Marking Notes
(a) (i)	$A(6,2)$ and $B(-2,-4)$	**Scale 5C (0, 2, 3, 5)** *Low Partial Credit:* Work of merit • One correct co-ordinate • Ordinates reversed *High Partial Credit:* Significant Work • One point correct *Full Credit:* • Correct answer
(a) (ii)	$\left[\frac{6+(-2)}{2}, \frac{2+(-4)}{2}\right]$ $(2,-1)$ Graphical Solution:  	**Scale 5C (0, 2, 3, 5)** *Low Partial Credit:* Work of merit • Some correct substitution into midpoint formula *High Partial Credit:* Significant Work • Full substitution into midpoint formula • One error and finishes correctly *Full Credit:* • Correct answer without supporting work

(a) (iii)		**Scale 5C (0, 2, 3, 5)** *Low Partial Credit:* Work of merit • Centre indicated • Circle drawn with centre not at $(2, -1)$ and not passing through either of the given points *High Partial Credit:* Significant Work • Circle with centre $(2, -1)$ but not passing through the given points
(a) (iv)	Radius $= \sqrt{16 + 9} = 5$ Equation: $(x - 2)^2 + \big(y - (-1)\big)^2 = 5^2$ $(x - 2)^2 + (y + 1)^2 = 25$	**Scale 10D (0, 3, 5, 8, 10)** *Low Partial Credit:* Work of merit • Some correct substitution into either correct relevant formula *Mid Partial credit:* • Finds $\lvert\text{Diameter}\rvert$ or $\lvert\text{Radius}\rvert$ • Some correct substitution into both correct relevant formula *High Partial Credit:* Significant Work • Equation of circle fully substituted • Error in substitution into formula and finished correctly

(b)	$(x-2)^2+(y+1)^2=25$ $(2-2)^2+(k+1)^2=25$ $k^2+2k+1=25.$ $k^2+2k-24=0$ $(k+6)(k-4)=0$ $k=-6$ or $k=4$ $k=4$ (first quadrant) [$P(2,4)$ plotted on diagram above] Graphical Solution:  	**Scale5D (0, 2, 3, 4, 5)** *Low Partial Credit:* Work of merit • $P(2,4)$ *or* $k=4$ but no algebra used to find k • Eq. of circle formula with some relevant substitution • Length of radius formula with some relevant substitution *Mid Partial credit:* • Equation fully substituted *High Partial credit:* Significant Work • Equation solved but $P(2,4)$ not plotted

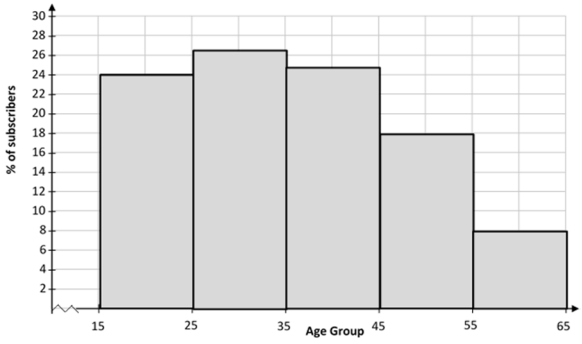
Q5	Model Solution – 30 Marks	Marking Notes
(a)	Mean: $$\frac{178{\cdot}7 + 147{\cdot}9}{2} = 163{\cdot}3$$ or $$147{\cdot}9 + \left(\frac{178{\cdot}7 - 147{\cdot}9}{2}\right) = 163{\cdot}3$$ Std. Dev.: $4\sigma = 178{\cdot}7 - 147{\cdot}9 \quad \Rightarrow \ \sigma = 7{\cdot}7$ or $2\sigma = 178{\cdot}7 - 163{\cdot}3 \quad \Rightarrow \ \sigma = 7{\cdot}7$	**Scale10C (0, 3, 7, 10)** *Low Partial Credit:* Work of merit • Some explanation of the relevance of the empirical rule $\mu - 2\sigma,\ \mu + 2\sigma$ • Writes $178{\cdot}7 + 147{\cdot}9$ • Writes $178{\cdot}7 - 147{\cdot}9$ *High Partial credit:* Significant Work • Mean or Std. Dev. Correct
(b) **(i)**	(Scatter Plot below)  	**Scale10D (0, 3, 5, 8, 10)** *Low Partial Credit:* Work of merit • One correct plot *Mid Partial credit:* • Four correct plots *High Partial credit:* Significant Work • Six correct plots • All points plotted as (y, x)
(b) **(ii)**	$0{\cdot}2$ | $0{\cdot}9$ | ✓ $-0{\cdot}6$ |	**Scale 5B (0, 2, 5)** *Partial Credit:* Work of merit • $0{\cdot}2$ ticked
(b) **(iii)**	e.g. There is a strong positive linear relationship between height and arm span. e.g. Tall people are very likely to have a long arm span.	**Scale 5B (0, 2, 5)** *Partial Credit:* Work of merit • High correlation • Positive correlation

Q6	Model Solution – 30 Marks	Marking Notes
(a)(i)		**Scale 5C (0, 2, 3, 5)** *Low Partial Credit:* Work of merit • Pilot diagram drawn for $[AC]$ bisector • One correct arc drawn *High Partial Credit:* Significant Work • Mid-point of $[AC]$ shown but without visible construction or perpendicular line • Line perpendicular to $[AC]$ drawn but not through mid-point *Misreading (-1)* • Draws perpendicular bisector of the side $[AB]$ or $[BC]$ **Note:** Tolerance $\pm$ 0·2 cm
(a)(ii)		**Scale10D (0, 3, 5, 8, 10)** *Low Partial Credit:* Work of merit • Pilot diagram drawn *Mid Partial Credit:* • Additional correct bisector drawn other than $[AC]$ • Centroid or orthocentre drawn correctly *High Partial Credit:* Significant Work • Correct construction of circumcentre but circle not drawn • Incircle constructed and drawn correctly **Note:** Tolerance $\pm$ 0·2 cm

3

(b)(i)	$\lvert QR\rvert = 3 \times 2{\cdot}5 = 7{\cdot}5$ cm	**Scale 5B (0, 2, 5)** *Partial Credit:* Work of merit • Relevant work with $2{\cdot}5$ and 3 *Full Credit:* • Correct answer without supporting work
(b)(ii)	Area $DEF = \dfrac{18{\cdot}75}{2{\cdot}5^2} = 3$ cm^2	**Scale 10C (0, 3, 7, 10)** *Low Partial Credit:* Work of merit • Relevant work with $2{\cdot}5$ and $18{\cdot}75$ e. g. $\dfrac{18{\cdot}75}{2{\cdot}5} = 7{\cdot}5$ *High Partial Credit:* Significant Work • Relevant work with $2{\cdot}5^2$ and $18{\cdot}75$

Section B

Q7	Model Solution – 50 Marks	Marking Notes
(a) (i)		**Scale 15C (0, 5, 10, 15)** *Low Partial Credit:* Work of merit • One correct column height indicated *High Partial Credit:* Significant Work • Three correct columns drawn • All correct height columns drawn but gaps between them
(a) (ii)	$\frac{27+25+16}{100} = 68\%$ $68\% \times 1000 = 680 \text{ people}$ or $270 + 250 + 160 = 680$	**Scale 5C (0, 2, 3, 5)** *Low Partial Credit:* Work of merit • Work with any Two of $27, 25, 16$ *High Partial Credit:* Significant Work • Works to $27 + 25 + 16 = 68$ *Full Credit:* • Correct answer without supporting work
(a) (iii)	The 25 to 35 age group	**Scale 5B (0, 2, 5)** *Partial Credit:* Work of merit • Median interpreted as 50%, Middle or Half *Full Credit:* • Correct answer without supporting work

(a) **(iv)**	$[(24 \times 20) + (27 \times 30) + (25 \times 40)$ $+(16 \times 50) + (8 \times 60)] \div 100$ $= \frac{3570}{100}$ $= 35{\cdot}7$	**Scale 10C (0, 3, 7, 10)** *Low Partial Credit:* Work of merit • Calculates a mid-interval value • Effort at adding data • 24×20 or equivalent • Division by 100 *High Partial Credit:* Significant Work • Formula substituted correctly but not evaluated • Consistent incorrect mid interval values, finished correctly • One error and finishes correctly *Full Credit:* • Correct answer without supporting work

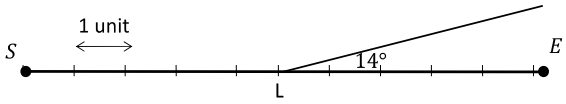
(b) **(i)**	$\frac{1}{\sqrt{540}} = 0{\cdot}043 = 4{\cdot}3\%$	**Scale 5C (0, 2, 3, 5)** *Low Partial Credit:* Work of merit • Writes $\frac{1}{\sqrt{n}}$ • Reference to multiplication by 100 *High Partial Credit:* Significant Work • Correct formula fully substituted $\frac{1}{\sqrt{540}}$ • Answer as 0·043 *Full Credit:* • Correct answer without supporting work
(b) **(ii)**	$\hat{p} = \frac{372}{540} = 0{\cdot}6888 = 68{\cdot}9\%$ 95% confidence interval $=$ $\left[\hat{p} - \frac{1}{\sqrt{n}} \ , \quad \hat{p} + \frac{1}{\sqrt{n}}\right]$ $[(68{\cdot}9 - 4{\cdot}3), (68{\cdot}9 + 4{\cdot}3)]$ $[64{\cdot}6\% \ , \ 73{\cdot}2\%]$	**Scale 5C (0, 2, 3, 5)** *Low Partial Credit:* Work of merit • Writes answer from (b)(i) in this part • $\hat{p} = \frac{372}{540}$ • $\hat{p} \pm \frac{1}{\sqrt{n}}$ • $\hat{p} \pm 1{\cdot}96\sqrt{\frac{p(1-p)}{n}}$ *High Partial Credit:* Significant Work • One boundary formed $(68{\cdot}9 - 4{\cdot}3$ or $68{\cdot}9 + 4{\cdot}3)$ • Correct answer without supporting work

(b) (iii)	$H_0 =$ the Netflix share of the market has not changed. or $(H_0: p = 65\%)$ $H_1 =$ the Netflix share of the market has changed or $(H_1: p \neq 65\%)$ $65\% \in [64{\cdot}6\%,\ 73{\cdot}2\%]$ (Fail to reject H_0 and) conclude that the Netflix share of the market has not changed	**Scale 5C (0, 2, 3, 5)** *Low Partial Credit:* Work of merit • Any one of H_0, H_1, or Confidence interval written *High Partial Credit:* Significant Work • H_0, H_1, and reference to C.I. • Conclusion (from correct work) not in context

Q8	Model Solution – 50 Marks	Marking Notes
(a) (i)	$A = \frac{10}{2}(10 + 0 + 2[200])$ $= 5(410)$ $= 2050 \text{ m}^2$ or $A = \frac{10}{2}\left(0 + 0 + 2[110] + \frac{10}{2}(10 + 0 + 2[90])\right)$ $= 1100 + 950$ $= 2050 \text{ m}^2$	**Scale15D (0, 4, 7, 11, 15)** *Low Partial Credit:* Work of merit • Trapezoidal Rule formula with some substitution *Mid Partial credit:* • Area of one section found *High Partial credit:* Significant Work • Trapezoidal Rule formula with full substitution (for both sections) *Misreading* (–1) Works correctly with Simpson's Rule to Answer $\left(2233{\cdot}\dot{3} \text{ m}^2\right)$
(a) (ii)	$V = 2050 \times 8 = 16400 \text{ m}^3$	**Scale 5B (0, 2, 5)** *Partial Credit:* Work of merit • Some correct substitution into Volume formula *Full Credit:* • Correct answer without supporting work

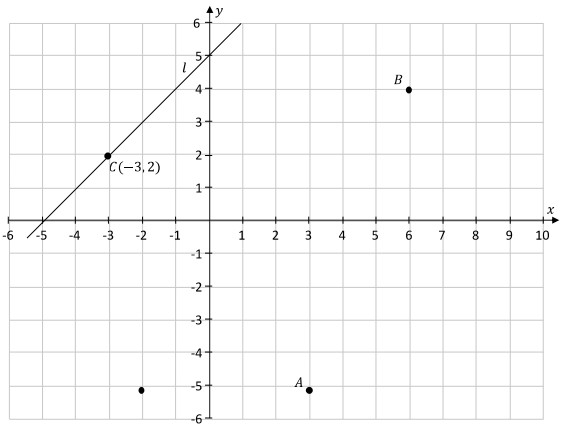
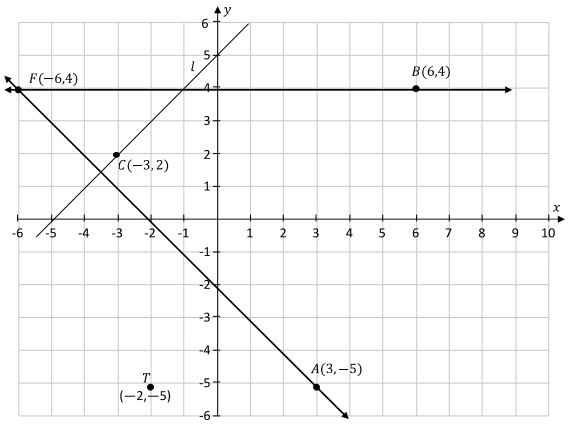
(b) **(i)**	$V = \frac{2}{3}\pi(21^3) = 6174\pi$ (cm^3)	**Scale 5B (0, 2, 5)** *Low Partial Credit:* Work of merit • Writes volume of hemisphere formula • Volume of sphere formula with some • correct substitution • Volume of sphere(12348π cm^3) and stops **Note**: F* applies to: Answer (19396 cm^3) Answer (19386 cm^3) for ($3{\cdot}14$) Answer (19404 cm^3) for $\left(\frac{22}{7}\right)$ *Full Credit:* • Correct answer without supporting work

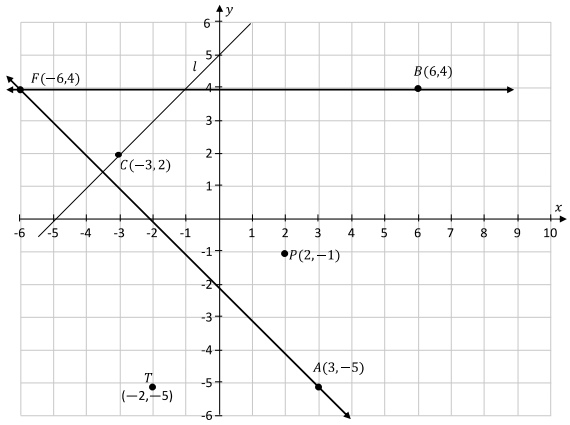
(b) **(ii)**	$$V = \frac{1}{3}\pi r^2 h$$ $$\frac{1}{3}\pi r^2 h = 6174\pi$$ $$h = \frac{6174}{\frac{1}{3}r^2}$$ or $$h = \frac{6174}{\frac{1}{3}(21)^2}$$ $$= 42$$ $$\text{Total Height} = 42 + 21$$ $$= 63 \text{ cm}$$	**Scale10D (0, 3, 5, 8, 10)** *Low Partial Credit:* Work of merit • Some correct substitution for volume of cone. • Volume of cone = Ans b(i) *Mid Partial Credit:* • Forms equation in h isolated *High Partial Credit:* Significant Work • Height of cone found • One error and finishes correctly
(c)	$$60^2 = 26^2 + 43^2 - 2(26)(43)\cos A$$ $$\cos A = \frac{26^2 + 43^2 - 60^2}{2(26)(43)}$$ $$= -\frac{25}{52}$$ $$\Longrightarrow A = 118{\cdot}74°$$	**Scale 15D (0, 4, 7, 11, 15)** *Low Partial Credit:* Work of merit • Any correct substitution into the Cosine Rule *Mid Partial Credit:* • Two variables correctly substituted into correct relevant formula *High Partial Credit:* Significant Work • Fully correct substitution • One incorrect substitution followed by correct calculation • Correct answer without supporting work • Incorrect calculator mode (once only) Radian $= 2{\cdot}07$ Gradian $= 131{\cdot}93$ *Zero Credit:* • Treats triangle as right-angled /Sine Rule

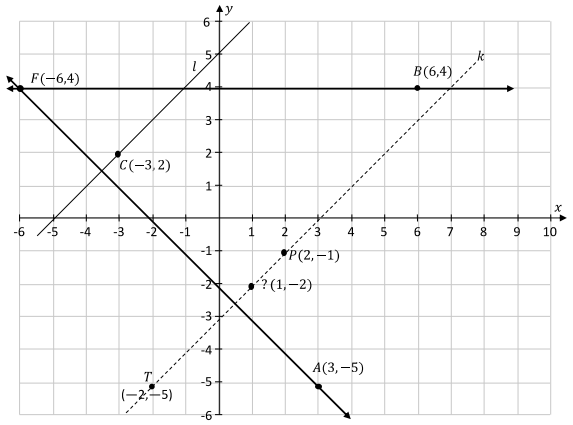
Q9	Model Solution – 50 Marks	Marking Notes
(a) (i)	$250 \times 10 = 2500$ $= \frac{2500}{1000}$ $= 2{\cdot}5$	**Scale 10C (0, 3, 7, 10)** *Low Partial Credit:* Work of merit • Numbering units • Incorrect work with 250 or 10 *High Partial Credit:* Significant work • $250 \times 10 = 2500$ • Error in converting to km *Full Credit:* • Correct answer without supporting work
(a) (ii)		**Scale 5B (0, 2, 5)** *Partial Credit:* Work of merit • L marked but in incorrect position • L marked correctly but angle incorrect **Notes**: • Correct work but L not indicated merits (F*) **Note:** Tolerance $\pm 1°$

(a) (iii)	$\cos 14° = \frac{1250}{h}$ $\Rightarrow \mathrm{h} = 1288{\cdot}267$ $\mathrm{h} = 1288$ $\text{Total Distance} = 1288 + 1250$ $= 2538$	**Scale10D (0, 3, 5, 8, 10)** *Low Partial Credit:* Work of merit • Correct trigonometric ratio or relevant formula with some substitution • Indicates addition of 1250 *Mid Partial Credit:* • Formula fully substituted $(\cos 14° = \frac{1250}{k})$ *High Partial Credit:* Significant Work • Evaluates h to 1288·267 • One incorrect substitution and finished correctly • Correct answer without supporting work • Incorrect calculator mode but otherwise correct (once only) **Note:** Radian: $h = 9142$; Distance $= 10392$ Gradian: $h = 1281$; Distance $= 2531$

(b) **(i)**	$\frac{x}{\sin 47} = \frac{260}{\sin 36}$ $x = \frac{260(\sin 47)}{\sin 36}$ $x = 323{\cdot}5058411$ $x = 323{\cdot}506$ $x = 324$	**Scale 15D (0, 4, 7, 11, 15)** *Low Partial Credit:* Work of merit • Any work of merit to identify the remaining angle required *Mid Partial Credit:* • Sine Rule with some substitution *High Partial Credit:* Significant Work • Sine Rule fully substituted • One incorrect substitution followed by correct calculation • Correct answer without supporting work • Incorrect calculator mode but otherwise correct (once only) *Zero Credit:* • Treats triangle as right angled **Note:** Radian: $x = —32$ Gradian: $x = 327$
(b) **(ii)**	$\mathrm{C} = 2\pi(10)\left(\frac{70}{360}\right)$ $C = 12{\cdot}217$ $\text{Total Distance} = 10 + 10 + 12{\cdot}21$ $= 32{\cdot}217$ $= 32{\cdot}22$	**Scale 10D (0, 3, 5, 8, 10)** *Low Partial Credit:* Work of merit • Reference to $\frac{70}{360}$ • Arc Length formula with some correct substitution. • Ignores C answer as $10 + 10 = 20$ *Mid Partial Credit:* • $\mathrm{C} = 2\pi(10) \times \frac{70}{360}$ *High Partial Credit:* Significant Work • Evaluates arc length to $12{\cdot}217$ • One incorrect substitution and finished correctly • Correct answer without work

10	Model Solution – 50 Marks	Marking Notes
(a) (i)		**Scale 10B (0, 5, 10)** *Partial Credit:* • Point plotted as $(-5, -2)$ • One or both coordinates plotted as a + value
(a) (ii)	$F(-6, 4)$  or $y-(-5)=-1(x-3)$ $x+y=-2$ $y-4=0(x-6)$ $y=4$ $\Rightarrow x+4=-2$ $x=-6$ $F=(-6,4)$	**Scale 5C (0, 2, 3, 5)** *Low Partial Credit:* Work of merit • Slope = $\frac{\text{rise}}{\text{run}}$ • A or B labelled correctly • Equation of line with some correct substitution • One line correctly drawn through A or B *High Partial Credit:* Significant Work • Both lines correctly drawn, F not identified • Both equations found but not solved

(b) **(i)**	$$d = \sqrt{81 + 4}$$ $$= \sqrt{85}$$ $$= 9(\in \mathbb{N})$$ $$\Longrightarrow d^4 = 6561$$ **Note:** Accept $d = \sqrt{85}$, $d^4 = 7225$ for Full Credit	**Scale 10C (0, 3, 7, 10)** *Low Partial Credit:* Work of merit • Some correct substitution into formula to find d *High Partial Credit:* Significant Work • Formula fully substituted • Correct answer without work
(b) **(ii)**	$\lvert PB\rvert = \sqrt{16 + (m-4)^2} = \sqrt{41}$ $$16 + m^2 - 8m + 16 = 41$$ $$m^2 - 8m - 9 = 0$$ $$(m+1)(m-9) = 0$$ $$\Rightarrow m = -1$$ $$(m = 9 \text{ not valid})$$ $P(2,-1)$ (plot on map)  	**Scale 5D (0, 2, 3, 4, 5)** *Low Partial Credit:* Work of merit • Some substitution into Pythagoras or distance formula to find $\lvert PB\rvert$ *Mid Partial Credit:* • Formula fully substituted • Incorrect substitution into formula followed by consistent value of m *High Partial Credit:* Significant Work • Works to the quadratic equation • One relevant value of m identified but P not plotted **Note:** If 2 values of m given but only 1 point plotted award Full Credit

(c) **(i)**	$k: x - y - 3 = 0$ $T \in k \Longrightarrow (-2) - (-5) - 3 = 0$ $-2 + 5 - 3 = 0$ $[5 - 5 = 0]$ $[0 = 0$ True$]$	**Scale 5C (0, 2, 3, 5)** *Low Partial Credit:* Work of merit • Some correct substitution into equation of line k *High Partial Credit:* Significant Work • Full correct substitution into equation of line k
(c) **(ii)**	Example: $k: x - y - 3 = 0$ $Let\ x = 1$ $\Longrightarrow 1 - y - 3 = 0$ $y = -2$ $(1, -2) \in k$  	**Scale 5C (0, 2, 3, 5)** *Low Partial Credit:* Work of merit • Random selection of a domain value to find a point $(x\ , y) \in k$ • Graphical solution *High Partial Credit:* Significant Work • Correct calculation of the corresponding range value **Note:** Correct substitution of any point that is shown to satisfy the equation of line k merits Full Credit

(c) **(iii)**	$k: x - y - 3 = 0$ $y = x - 3$ $\Longrightarrow m_l = 1$ $\Longrightarrow m_k = 1$ Eqn of l: $y - 2 = 1[x - (-3)]$ $y - 2 = x + 3$ or $y = x + 5$ or $l: x - y + 5 = 0$	**Scale10C (0, 3, 7, 10)** *Low Partial Credit:* Work of merit • Effort at finding slope of k or l • Relevant work on diagram • Slope = $\frac{\text{rise}}{\text{run}}$ *High Partial Credit:* Significant Work • Equation of line formula with full substitution **Note:** Accept $y - 2 = 1(x + 3)$ for Full Credit