Coimisiún na Scrúduithe Stáit
State Examinations Commission

Leaving Certificate 2018

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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Leaving Certificate Examination 2018

Mathematics

Ordinary Level

Paper 1

Solutions and Marking scheme

300 marks

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, 3, 5	0, 3, 4, 5	0,2,3,4,5	
10 mark scales	0, 10	0, 5, 10	0, 3, 8, 10	0, 2, 6, 8, 10	
15 mark scales	0, 15	0, 7, 15	0, 4, 12, 15	0, 3, 7, 13, 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

Summary of mark allocations and scales to be applied

Section A			Section B		
Question 1			Question 7		
(a)	10D		(a)	5B	
(b)	5C		(b)	10C	
(c)	10C		(c)	10C	
			(d)	10C	
Question 2			(e)	5C	
(a)	15D		(f)(i)	5C	
(b)	5D		(f)(ii)	10C	
(c)	5C				
			Question 8		
Question 3			(a)	10C	
(a)	10D		(b)	10C	
(b)	15D		(c)	5C	
			(d)(i)	5C	
Question 4			(d)(ii)	10C	
(a)	5B		(e)(i)	10C	
(b)	5C		(e)(ii)	5C	
(c)	5C		(e)(iii)	5C	
(d)	10C		(e)(iv)	5D	
Question 5			Question 9		
(a)	5C		(a)(i)	5B	
(b)	10C		(a)(ii)	5C	
(c)	10C		(b)(i)	5B	
			(b)(ii)	15C	
Question 6					
(a)	10C				
(b)	15D				

Note: 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.
Rounding and units penalty to be applied only once in each part (a), (b), (c) etc.
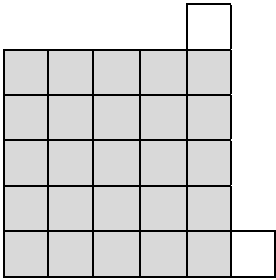Throughout the scheme indicate by use of * where an arithmetic error occurs.

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.

Q1	Model Solution – 25 Marks	Marking Notes
(a)	Contract A $35000 + 400000 \times 0{\cdot}02$ $\qquad\qquad = €43\,000$ Contract B $\qquad 30000 + 400000 \times 0{\cdot}03$ $\qquad\qquad = €42\,000$	**Scale 10D (0, 2, 6, 8, 10)** *Low Partial Credit:* • Use of 2% or 3% *Mid Partial Credit* • 8000 or 12000 or both *High Partial Credit:* • One contract correct **Note**: Accept correct answer without work
(b)	$50000 - 35000 = 15000$ $(15000 \div 0{\cdot}02) = €750\,000$	**Scale 5C (0, 3, 4, 5)** *Low Partial Credit:* • $50000 - 35000$ formulated or 15000 *High Partial Credit:* • $15000 \times 0{\cdot}02$ or equivalent $= 300$ **Note**: Accept correct answer without work
(c)	$35000 + 0{\cdot}02x = 30000 + 0{\cdot}03x$ $\qquad\qquad x = €500\,000$ **Or** 1% = €5000 Answer = €500 000	**Scale 10C (0, 3, 8, 10)** *Low Partial Credit:* • $35000 - 30000$ or 5000 written • correct answer without work *High Partial Credit:* • $35000 + 0{\cdot}02x = 30000 + 0{\cdot}03x$ • $\frac{x}{100} = 5000$

Q2	Model Solution – 25 Marks	Marking Notes
(a)	$$z_3 = -2 + 3i + 3 + 2i = 1 + 5i$$	**Scale 15D (0, 3, 7, 13, 15)** *Low Partial Credit:* • $z_3 = z_1 - z_2$ with some substitution • 1 or 2 correct plots (z_1 and/or z_2) without labels *Mid Partial Credit* • z_3 correct, with or without plotting • 2 correct plots (z_1 and z_2) with labels *High Partial Credit:* • Plot of incorrect z_3 and 2 correct plots labelled • Mixes up real and imaginary axes but plots and labels 3 points 'correctly'
(b)	$$\sqrt{13} + \sqrt{13} \neq \sqrt{26}$$	**Scale 5D (0, 2, 3, 4, 5)** *Low Partial Credit:* • $|z_1|$ or $|z_2|$ or $|z_3|$ formulated with some substitution • Correct formula *Mid Partial Credit:* • $|z_1|$ or $|z_2|$or $|z_3|$ correct *High Partial Credit:* • $|z_1|$ and $|z_2|$ and $|z_3|$ correct but no conclusion or incorrect conclusion
(c)	$$\frac{(-2 + 3i)(-3 + 2i)}{(-3 - 2i)(-3 + 2i)}$$ $$= 0 - 1i$$	**Scale 5C (0, 3, 4, 5)** *Low Partial Credit:* • Some correct substitution • Conjugate identified • Some multiplication above and below by same number, even if incorrect conjugate • correct answer without work *High Partial Credit:* • $\frac{(-2+3i)(-3+2i)}{(-3-2i)(-3+2i)}$

Q3	Model Solution – 25 Marks	Marking Notes
(a)	$$\frac{7 \pm \sqrt{(-7)^2 - 4(2)(-3)}}{4}$$ $$= 3 \cdot 89 \quad \text{or} \quad -0 \cdot 39$$	**Scale 10D (0, 2, 6, 8, 10)** *Low Partial Credit:* - correct roots formula - a or b or c identified - attempt at factorising - correct answer without work *Mid Partial Credit:* - formula fully substituted *High Partial Credit:* - one root calculated $x = \frac{7 \pm \sqrt{73}}{4}$ and stops
(b)	$$-2a - 3b = -15$$ $$\underline{15a + 3b = -24}$$ $$13a = -39$$ $$a = -3 \text{ and } b = 7$$	**Scale 15D (0, 3, 7, 13, 15)** *Low Partial Credit:* - effort to equate a or b coefficient in both equations - correct answer without work *Mid Partial Credit:* - eliminates one unknown *High Partial Credit:* 1 unknown found

Q4	Model Solution – 25 Marks	Marking Notes
(a)		**Scale 5B (0, 3 ,5)** *Partial Credit:* • correct diagram, no shading • 5^2 written

(b)

Pattern number (n)	Number of Grey Tiles	Number of White Tiles	Total Number of Tiles
1	4	2	6
2	9	2	11
3	16	2	18
4	25	2	27
5	36	2	38

Scale 5C (0, 3, 4, 5)
Low Partial Credit:
• At least 1 correct new entry

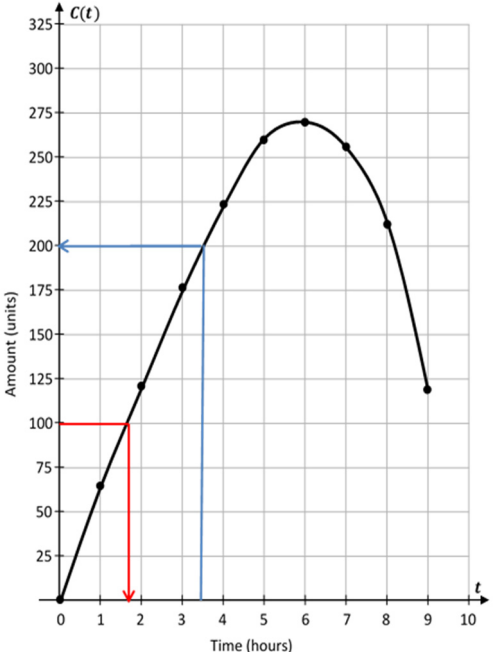*High Partial Credit*:
• At least 6 correct or consistent new entries

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(c)	$(n + 1)^2 + 2$ $n^2 + 2n + 3$ **Or** $n = 1 \quad \Rightarrow \quad b + c = 5$ $n = 2 \quad \Rightarrow 2b + c = 7$ $b = 2$ $c = 3$	**Scale 5C (0, 3, 4, 5)** *Low Partial Credit:* • $(n)^2 + 2$ written and stops or continues • Effort at substitution to derive one equation in a and b • correct answer without work *High Partial Credit:* • $(n + 1)^2 + 2$ • 2 relevant equations derived
(d)	$n^2 + 2n + 3 = 443$ $n^2 + 2n - 440 = 0$ $n = 20$ **Or** $6, 11, 18, \quad ., \quad ., \quad ., \quad 443$ $n = 20$	**Scale 10C (0, 3, 8, 10)** *Low Partial Credit:* • $n^2 + 2n + 3 = 443$ • effort at trial and error involving any term beyond T_5 *High Partial Credit:* • $n^2 + 2n - 440 = 0$ • $(21)^2 + 2 = 443$ **Note**: Accept $n = 20$ without work for full marks

Q5	Model Solution – 25 Marks	Marking Notes
(a)	$A = (\ 0,\ 6\ )$ $B = (-2,\ 0\ )$ $C = (\ 3,\ 0\ )$	**Scale 5C (0, 3, 4, 5)** *Low Partial Credit:* • 1 point correctly identified *High Partial Credit*: • 2 points correctly identified • mixes up axes consistently for the 3 points
(b)	$$f(x) = ax^2 + bx + c$$ $$c = 6$$ $$0 = (-2)^2 a + b(-2) + 6$$ $$-6 = 4a - 2b$$ $$0 = (3)^2 a + b(3) + 6$$ $$-6 = 9a + 3b$$ ___ $$-6 = 9a + 3b$$ $$-6 = 4a - 2b$$ $$a = -1,\ \ b = 1$$ **Or** $$-(x+2)(x-3)$$ $$= -x^2 + x + 6$$	**Scale 10C (0, 3, 8, 10)** *Low Partial Credit:* • $c = 6$ • substitution of *A* or *B* or *C* into given equation or $ax^2 + bx + c$ • 1 factor written *High Partial Credit*: • substitution of any 2 of *A*, *B*, or *C* into given equation worked out • substitution of *A*, *B*, and *C* into $ax^2 + bx + c$ • $\pm(x+2)(x-3)$ **Note**: *A*, *B* and *C* substituted into $-x^2 + x + 6$ and fully verified merits full marks
(c)	$$f(x) = -x^2 + x + 6$$ $$f'(x) = -2x + 1 = 0$$ $$x = \frac{1}{2}$$ $$-\left(\frac{1}{2}\right)^2 + \frac{1}{2} + 6 = 6{\cdot}25$$	**Scale 10C (0, 3, 8, 10)** *Low Partial Credit:* • any effort at differentiation • states $f'(x) = 0$ *High Partial Credit*: • $x = \frac{1}{2}$

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Q6	Model Solution – 25 Marks	Marking Notes
(a)	$(x+5)(3x-4) - 3(x^2+2) + 4 = 0$ $3x^2 - 4x + 15x - 20 - 3x^2 - 6 + 4$ $= 0$ $11x = 22$ $x = 2$	**Scale 10C (0, 3, 8, 10)** *Low Partial Credit:* • any correct multiplication • correct answer without work *High Partial Credit*: • multiplication fully correct • error in expanding brackets but finishes correctly
(b)	$(2x)(x+3)\left(\dfrac{5}{x+3} - \dfrac{1}{x}\right)$ $= \dfrac{1}{2}(2x)(x+3)$ $10x - 2(x+3) = x(x+3)$ $x^2 - 5x + 6 = 0$ $x = 2 \quad \text{and} \quad x = 3$	**Scale 15D (0, 3, 7, 13, 15)** *Low Partial Credit:* • common denominator identified • $5x - (x+3)$ or similar • correct answer without work, 2 and/or 3 • writes $\dfrac{-b \pm \sqrt{(b)^2 - 4ac}}{2a}$ *Mid Partial Credit*: • $10x - 2(x+3) = x(x+3)$ or similar *High Partial Credit*: • $x^2 - 5x + 6 = 0$ or equivalent

	Section B	
Q7	**Model Solution – 55 Marks**	**Marking Notes**
(a)	37	**Scale 5B (0, 3, 5)** *Partial Credit:* • correct number of seats for any row between row 4 and row 9 (inclusive) **Note:** Accept 37 without work
(b)	$28 + (n-1)1 = 50$ $27 + n = 50$ $n = 23$ **Or** $50 - 37 = 13$ $13 + 10 = 23$	**Scale 10C (0, 3, 8, 10)** *Low Partial Credit:* • any evidence of counting (e.g. listing 28, 29,…) • 13 or 22 without work • writes T_n = a + (n-1)d • a or d identified *High Partial Credit:* • $50 - 28$ or $50 - 37$ • $28 + (n-1)1 = 50$ **Note:** Accept 23 without work
(c)	$S_{23} = \dfrac{23}{2}[2(28) + (22)(1)]$ $S_{23} = 897$ (seats) **Or** $28 + 29 + \ldots + 50 = 897$	**Scale 10C (0, 3, 8, 10)** *Low Partial Credit:* • S_n formula written • any evidence of counting (e.g. listing 28 + 29 + 30 +…) • a or d identified *High Partial Credit:* • full listing with addition indicated but incorrect solution • S_n formula fully substituted **Note:** Accept 897 without work

(d)	$\dfrac{n}{2}(56 + n - 1) = 600$ $n^2 + 55n - 1200 = 0$ $n = 16 \cdot 7$ $S_{16} = 568$ $600 - 568 = 32$ people in next row **Or** $[28 + 29 + \ldots + 43] = 568$ $600 - 568 = 32$ 16 rows and 32 in next **Or** $([28 + 29 + \ldots + 44] = 612$ $612 - 44 = 568$ $600 - 568 = 32$ $(17 - 1 = 16)$ rows and 32 in next	**Scale 10C (0, 3, 8, 10)** *Low Partial Credit:* • S_n formula written • a or d identified • any evidence of counting (e.g. listing 28 + 29 + 30 +…) *High Partial Credit*: • $n^2 + 55n - 1200 = 0$ • $\dfrac{n}{2}(56 + n - 1) = 600$ • full listing to 16 or 17 terms with addition indicated but incorrect solution **Note:** Accept (16, 32) without work
(e)	$276(25) + 212(12)$ $6900 \quad + 2544 \qquad = €9\,444$	**Scale 5C (0, 3, 4, 5)** *Low Partial Credit:* • $276(25)$ • $212(12)$ *High Partial Credit*: • $276(25) + 212(12)$ formulated **Note**: Accept correct answer without work
(f) (i)	$\dfrac{752}{4} = 188$ Children's tickets $188 \times 3 = 564$ Adult tickets	**Scale 5C (0, 3, 4, 5)** *Low Partial Credit:* • 4 • $\dfrac{752}{x}, \; x \neq 4, 1$ *High Partial Credit:* • 188 found or 564 **Note**: Accept correct answer without work
(f) (ii)	$188x + 564(2 \cdot 5x) = 17\,578$ $1598x = 17\,578$ $x = €11$	**Scale 10C (0, 3, 8, 10)** *Low Partial Credit:* • $x, \; 2 \cdot 5x$ • correct answer without work *High Partial Credit*: • $188x + 564(2 \cdot 5x) = 17\,578$, or consistent with f(i)

Q8	Model Solution – 65 Marks		Marking Notes
(a)	$C(4) = -(4^3) + 4 \cdot 5(4)^2 + 54(4)$ $= 224$		**Scale 10C (0, 3, 8, 10)** *Low Partial Credit:* • Function with some substitution of 4 *High Partial Credit:* • Function fully substituted

(b)

t (Hours)	0	1	2	3	4	5	6	7	8	9
$C(t)$ (Units)	0	57·5	118	175·5	224	257·5	270	255·5	208	121·5

Scale 10C (0, 3, 8, 10)
Low Partial Credit:
• 1, 2 or 3 correct new entries

High Partial Credit:
• 4, 5 or 6 correct new entries

(c)

Scale 5C (0, 3, 4, 5)
Low Partial Credit:
• 1 to 4 correct plots

High Partial Credit:
• 5 to 9 correct plots
• all points correctly plotted but incorrect or no joining

(d) **(i)**	200 units	**Scale 5C (0, 3, 4, 5)** *Low Partial Credit:* • 3·5 shown on horizontal axis *High Partial Credit:* • correct construction shown but no indication of 200
(d) **(ii)**	1 hour 45 mins	**Scale 10C (0, 3, 8, 10)** *Low Partial Credit:* • 100 clearly indicated on vertical axis *High Partial Credit:* • correct construction shown but no indication of 1 hour 45 minutes
(e) **(i)**	$C'(t) = -3t^2 + 9t + 54$	**Scale 10C (0, 3, 8, 10)** *Low Partial Credit:* • any correct differentiation or indication of differentiation *High Partial Credit:* • 2 terms correctly differentiated
(e) **(ii)**	$C'(4) = -3(4)^2 + 9(4) + 54$ $= 42$ units / hour	**Scale 5C (0, 3, 4, 5)** *Low Partial Credit:* • some substitution of 4 into C' or writes $C'(4)$ *High Partial Credit:* • $C'(4) = -3(4)^2 + 9(4) + 54$ **Note**: Accept correct or consistent answer without work

(e) **(iii)**	$-3t^2 + 9t + 54 = 0$ $t^2 - 3t - 18 = 0$ $(t - 6)(t + 3) = 0$ $t = 6, \quad t = -3$ $t = 6$ Amount of drug $= 270$ units	**Scale 5C (0, 3, 4, 5)** *Low Partial Credit:* • $C'(t) = 0$ • correct answer without work *High Partial Credit:* • $t = 6$ from calculus
(e) **(iv)**	$C'(7) = -3(7)^2 + 9(7) + 54$ $= -30$ units / hour Rate is negative so the amount of the drug is decreasing	**Scale 5D (0, 2, 3, 4, 5)** *Low Partial Credit:* • some substitution of 7 into C' or writes $C'(7)$ *Mid Partial Credit:* • $C'(7) = -3(7)^2 + 9(7) + 54$ *High Partial Credit:* • -30 units / hour

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Q9	Model Solution – 30 Marks	Marking Notes
(a) **(i)**	$$s = \sqrt{9{\cdot}8(2000)} = 140$$	**Scale 5B (0, 3 ,5)** *Partial Credit:* • Any relevant substitution **Note**: Accept correct answer without work
(a) **(ii)**	$$\frac{400000}{140} = 2857{\cdot}14 \text{ sec}$$ $$= 47{\cdot}62 \text{ mins}$$ $$= 48 \text{ mins}$$	**Scale 5C (0, 3, 4, 5)** *Low Partial Credit:* • use of answer to Part (a)(i) • correct answer without work • 400000 written *High Partial Credit*: • $\frac{400000}{140}$
(b) **(i)**	$$s^2 = g \times d$$ $$d = \frac{s^2}{g}$$	Scale 5B (0, 3, 5) *Low Partial Credit:* • effort to square both sides
(b) **(ii)**	$$d = \frac{55^2}{9{\cdot}8}$$ $$d = 308{\cdot}67$$ $$d = 309$$ **Or** $$55 = \sqrt{9{\cdot}8 \times d}$$ $$d = \frac{55^2}{9{\cdot}8}$$ $$d = 308{\cdot}67$$ $$d = 309$$	**Scale 15C (0, 4, 12, 15)** *Low Partial Credit:* • some substitution into either formula • correct answer without work *High Partial Credit:* • $d = \frac{55^2}{9{\cdot}8}$

Coimisiún na Scrúduithe Stáit
State Examinations Commission

Leaving Certificate 2018

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, 2, 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
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Note: 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.

Rounding and units penalty to be applied only once in each part (a), (b), (c) etc.

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	(25 marks)
(a)(i)	5C
(a)(ii)	5B
(a)(iii)	5B
(b)	10C

Question 2	(25 marks)
(a)	5C
(b)	5D
(c)	10D
(d)	5C

Question 3	(25 marks)
(a)(i)+(ii)	10C
(b)(i)+(ii)	15D

Question 4	(25 marks)
(a)	5B
(b)	5C
(c)	10C
(d)	5C

Question 5	(25 marks)
(a)	10C
(b)(i)+(ii)	15D

Question 6	(25 marks)
(a)(i)+(ii)	10D
(b)(i)	5B
(b)(ii)	10C

Section B

Question 7	(60 marks)
(a)(i)+(ii)+(iii)	10C
(b)	5B
(c)	10C
(d)(i)	10C
(d)(ii)	5C
(e)	5B
(f)(i)	10C
(f)(ii)	5A

Question 8	(50 marks)
(a)	10C
(b)	10C
(c)	5B
(d)	15D
(e)	5C
(f)	5C

Question 9	(40 marks)
(a)(i)	10B
(a)(ii)	5B
(a)(iii)	5C
(b)(i)	5C
(b)(ii)	5C
(b)(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.

Q1	Model Solution – 25 Marks	Marking Notes
(a) (i)	<table><tr><td colspan="7" align="center">**Die 1**</td></tr><tr><td></td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td></tr><tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td></tr><tr><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td></tr><tr><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr><tr><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td></tr><tr><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td>11</td></tr><tr><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td>11</td><td>12</td></tr></table> (Die 2 labels the rows)	**Scale 5C (0, 2, 3, 5)** *Low Partial Credit:* • One correct entry. • Work of merit. *High Partial Credit:* • Four correct entries. *Full Credit:* • Correct answer without work. *Zero Credit*: • Correct answers outside box with no work.
(a) (ii)	$$\frac{6+2}{36} \ = \ \frac{8}{36} \ \text{ or } \ \frac{2}{9}$$	**Scale 5B (0, 2, 5)** *Partial Credit:* • Work of merit. *Full Credit:* • Correct answer without work. *Zero Credit:* • Probability > 1, without work.
(a) (iii)	$$\frac{1+2+4+6+2}{36} \ = \ \frac{15}{36} \ \text{ or } \ \frac{5}{12}$$	**Scale 5B (0, 2, 5)** *Partial Credit:* • Prime Number identified. • Work of merit. *Full Credit:* • Correct answer without work. *Zero Credit:* • Probability > 1, without work.

(b)	$$\frac{18+8}{30} = \frac{26}{30} = \frac{13}{15}$$ Or $$\frac{30-4}{30} = \frac{26}{30} = \frac{13}{15}$$ Or $$\frac{18+(11+8)-11}{30} = \frac{26}{30}$$	**Scale 10C (0, 3, 7, 10)** *Low Partial Credit:* • Any relevant work towards creating at least one correct probability. (18 + 8, 30 – 4, 18 + 19 -11) *High Partial Credit:* • Significant work towards answer. *Full Credit:* • Correct answer without work. *Zero Credit:* • Probability > 1, without work.

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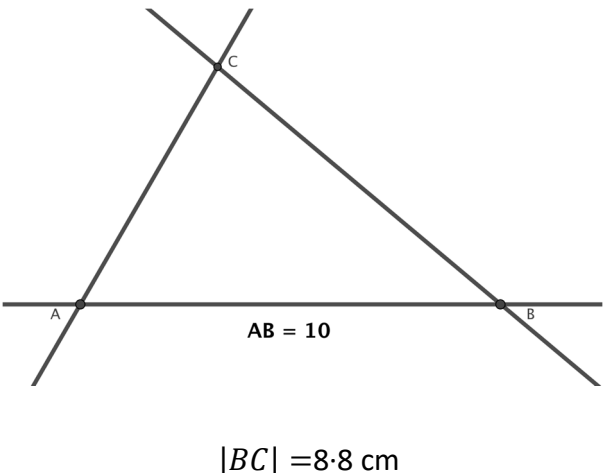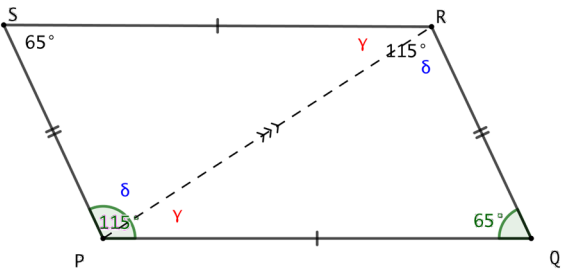| Q2	Model Solution – 25 Marks	Marking Notes
(a)	**Method 1 : Midpoint formula** $$V = \left(\frac{x_1 + x_2}{2}, \frac{y_1 + y_2}{2}\right)$$ $$= \left(\frac{7 + 11}{2}, \frac{10 + 4}{2}\right)$$ $$= (9, 7)$$ OR **Method 2 : Translation** $(7,10) \rightarrow (11, 4)$ X $\uparrow$4, y $\downarrow$6 $(7,10) \rightarrow (9,7)$	**Scale 5C (0, 2, 3, 5)** *Low Partial Credit:* • Correct relevant formula with some correct substitution. • Correct translation identified. *High Partial Credit:* • Formula fully substituted. *Full Credit:* • Correct answer without work.
(b)	Slope of $UV = \dfrac{y_2 - y_1}{x_2 - x_1} = \dfrac{7 - 6}{9 - 4} = \dfrac{1}{5}$ Slope of $QR = \dfrac{y_2 - y_1}{x_2 - x_1} = \dfrac{4 - 2}{11 - 1} = \dfrac{2}{10}$ Slope of $QR = \dfrac{1}{5}$ Conclusion: $$\text{Slope of } UV = \text{slope of } QR$$ $$or \ \ UV \parallel QR$$	**Scale 5D (0, 2, 3, 4, 5)** *Low Partial Credit:* • Correct relevant formula with some correct or consistent substitution. *Mid Partial Credit:* • One or both formulae fully substituted. *High Partial Credit:* • Both slopes calculated and no conclusion.

(c)	$$\text{Area} = \frac{1}{2}|x_1y_2 - x_2y_1|$$ $$= \frac{1}{2}|(-6)(-6) - (4)(-8)|$$ $$= \frac{1}{2}|36 + 32|$$ $$= 34 \text{ square units}$$	**Scale 10D (0, 2, 5, 8, 10)** *Low Partial Credit:* • Area of triangle formula with some relevant substitution. • Translation of any relevant point to (0, 0). *Mid Partial Credit:* • Area of triangle formula substituted correctly with TWO from P, Q, and R *High Partial Credit:* • Formula fully substituted with translated points • Area of triangle found from formula fully substituted with TWO from P, Q, and R
(d)	$$U(4,6) \rightarrow V(9,7)$$ $$\xrightarrow{(5,1)}$$ $$Q(1,2) \rightarrow S(6,3)$$ Or $$S = \left(\frac{x_1 + x_2}{2}, \frac{y_1 + y_2}{2}\right)$$ $$S = \left(\frac{1 + 11}{2}, \frac{2 + 4}{2}\right)$$ $$S = (6, 3)$$	**Scale 5C (0, 2, 3, 5)** *Low Partial Credit:* • Work with a translation which indicates an understanding of the concept. • Mid-Point Formula with some relevant substitution. *High Partial credit* • An incorrect translation applied correctly. • Correct translation applied to an incorrect point. • Correct formula fully substituted. *Full Credit:* • Correct answer without work.

Q3	Model Solution – 25 Marks	Marking Notes
(a) **(i)** **+** **(ii)**	$7! = 5040$ $7 \times 6 \times 5 = 210$	**Scale 10C (0, 3, 7, 10)** *Low Partial Credit:* • Any work of merit towards creating at least one correct solution. *High Partial Credit:* • One correct answer. • Answers given as correct list with multiplication clearly indicated but answers not worked out. *Full Credit:* • Correct answers without work.

(b)

(i)

+

Colour	Angle	Probability	Prize
Red	72°	$\dfrac{1}{5}$	€20
Orange	30°	$\dfrac{1}{12}$	€60
Yellow	45°	$\dfrac{1}{8}$	€24
Green	90°	$\dfrac{1}{4}$	€8
Blue	60°	$\dfrac{1}{6}$	€42
Indigo	18°	$\dfrac{1}{20}$	€90
Violet	45°	$\dfrac{1}{8}$	€48

Scale 15D (0, 4, 7, 11, 15)
Low Partial Credit:
• Any work of merit
e.g. One correct entry into table.

Mid Partial Credit:
• Four correct entries into table.
• All incorrect consistent probabilities found.
• E(X) correct with no work and no table.

High Partial Credit:
• Table correct or E(X) correct.
• Error/s in completed table and significant work in formulation of E(X).

(ii)

$$E(X) = \sum_{i=1}^{n}[X_1P(X_1) + X_2P(X_2) + \cdots X_nPX_n]$$

$$= 20\left(\tfrac{1}{5}\right) + 60\left(\tfrac{1}{12}\right) + 24\left(\tfrac{1}{8}\right) + 8\left(\tfrac{1}{4}\right) + 42\left(\tfrac{1}{6}\right) + 90\left(\tfrac{1}{20}\right) + 48\left(\tfrac{1}{8}\right)$$

$$= 4 + 5 + 3 + 2 + 7 + 4{\cdot}5 + 6$$

$$= 31{\cdot}50$$

Note:
• If expected values are correct but not added then award F^*

Q4	Model Solution – 25 Marks	Marking Notes
(a)	$$\text{Centre} = \left(\frac{x_1 + x_2}{2}, \frac{y_1 + y_2}{2}\right)$$ $$= \left(\frac{1 + 9}{2}, \frac{8 + 0}{2}\right)$$ $$= (5, 4)$$ **Method 2 : Translation** (1,8) →(Centre) X ↑4, y ↓4 (1,8) →(5,4)	**Scale 5B (0, 2, 5)** *Partial Credit:* • Mid-point formula with some correct substitution. • Leaves answer in fraction form. • Indicates centre. • Correct translation identified. *Full Credit:* • Correct answer without work.
(b)	$$|BC| = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$ $$= \sqrt{(9 - 5)^2 + (0 - 4)^2}$$ $$= \sqrt{(4)^2 + (-4)^2}$$ $$= \sqrt{16 + 16}$$ $$= \sqrt{32}$$ $$= 4\sqrt{2} \text{ units}$$	**Scale 5C(0, 2, 3, 5)** *Low Partial Credit:* • Correct formula with some correct or consistent substitution. *High Partial Credit:* • Formula fully substituted. • Correct answer without work.
(c)	$$(x - h)^2 + (y - k)^2 = r^2$$ $$(x - 5)^2 + (y - 4)^2 = \sqrt{32}^2$$ $$(x - 5)^2 + (y - 4)^2 = 32$$ **Or** $$x^2 + y^2 - 10x - 8y + 9 = 0$$	**Scale 10C(0, 3, 7, 10)** *Low Partial Credit:* • Correct formula with some correct or consistent substitution. *High Partial Credit:* • Answer as $$(x - 5)^2 + (y - 4)^2 = \sqrt{32}^2$$ *Full Credit:* • Correct or consistent answer without work.

(d)

$$m_r = -1$$

$$m_T = 1$$

$$y - 8 = 1(x - 1)$$

$$x - y + 7 = 0$$

Scale 5C (0, 2, 3, 5)
Low Partial Credit:
- Correct relevant formula with some correct substitution.
- Finds slope of radius and stops.

High Partial Credit:
- Eq. of line formula fully substituted.

Full Credit:
- Answer as $(-x + y - 7 = 0)$.

Misreading:
- Equation of tangent through B $(x - y - 9 = 0)$.

Q5	Model Solution – 25 Marks	Marking Notes
(a)	**Method 1:** Area of $PQRS$ $= A\text{rea of } ABCD - 4(\text{Area of } AQP)$ $= 7 \times 7 - 4[\frac{1}{2}(5) \times 2]$ $= 49 - 20$ $= 29 \text{ cm}^2$ **Method 2:** Area of $PQRS$ $$|PQ|^2 = |AQ|^2 + |AP|^2$$ $$|PQ|^2 = |5|^2 + |2|^2$$ $$|PQ|^2 = 29$$ $$|PQ| = \sqrt{29}$$ $$\text{Area of } PQRS = \left(\sqrt{29}\right)^2$$ $$A\text{rea of PQRS} = 29 \text{ cm}^2$$	**Scale 10C (0, 3, 7, 10)** *Low Partial Credit:* • Any work of merit e.g. Identifies $|QB|$ = 2. *High Partial Credit:* • Correct relevant expression for Area of $PQRS$ fully substituted. *Full Credit:* • Correct answer without work.
(b) **(i)** **+** **(ii)**	Circumference of $u = 2\pi r = 2\pi(4)$ $= 8\pi$ Circumference of $v = 2\pi r = 2\pi(6)$ $= 12\pi$ u will rotate $\dfrac{12\pi \times 100}{8\pi} = 150$	**Scale 15D (0, 4, 7, 11, 15)** *Low Partial Credit:* • Circumference formula with some substitution. • Any work of merit e.g. ratio of two circles. *Mid Partial Credit:* • One circumference found (in terms of π). • Both substitutions fully correct. *High Partial Credit:* • Both circumferences found (in terms of π) • Finds the number of rotations wheel u makes.

Q6	Model Solution – 25 Marks	Marking Notes
(a) (i) + (a) (ii)	$\|BC\| = 8{\cdot}8$ cm	**Scale 10D (0, 2, 5, 8, 10)** *Low Partial Credit:* • A labelled pilot diagram drawn. • One correct length or angle drawn. *Mid Partial Credit:* • Any two components correct and stops. *High Partial Credit:* • Construction correct but vertices incorrectly named or omitted and stops. *Misreading:* • Works with $\|AC\|$. **Note:** Tolerance $\pm\,0{\cdot}2$ cm. • $\|BC\|$ must be ONE from the list: $[(8{\cdot}6),(8{\cdot}7),(8{\cdot}8),(8{\cdot}9),(9{\cdot}0)]$
(b) (i)	$$\alpha = 115°$$ $$\beta = 180° - 115° = 65°$$ OR $$\beta = \frac{1}{2}[360° - (115° + 115°)] = 65°$$	**Scale 5B (0, 2, 5)** *Partial Credit:* • One correct angle. *Full Credit:* • Correct answers without work.
(b) (ii)	Side: $\|PQ\| = \|SR\|$ (Opposite sides of a parallelogram) Angle: $\|\angle PQR\| = \|\angle RSP\|$ (Opposite angles in a parallelogram) Side: $\|QR\| = \|PS\|$ (Opposite sides of a parallelogram) [Note that SSS or ASA may also be used]	**Scale 10C(0, 3, 7, 10)** *Low Partial Credit:* • Any work of merit e.g. One correct statement. *High Partial Credit:* • Two statements & Two reasons correct. *Full Credit:* • Three statements & Three reasons correct.

Section B

Q7	Model Solution – 60 Marks	Marking Notes
(a)	**(i)** Range= 155 – 47 = 108 mm **(ii)** Highest June rainfall = 2003 **(iii)** Least sunshine 2002	**Scale 10C (0, 3, 7, 10)** *Low Partial Credit:* • Any work of merit e.g. (a)(i): [155 and/or 47] (a)(ii): [155] (a)(iii):[124] *High Partial Credit:* • Two correct answers. • Significant work in all answers.
(b)	*Example* 2006 is the year with the best weather. It had the least rainfall and /or the highest number of hours of sunshine. Note: Other equally valid choices are possible if accompanied by a reasonable reason.	**Scale 5B (0, 2, 5)** *Partial Credit:* • Mention of year **without** reference to rainfall or sunshine. *Full Credit:* • Mention of year **with** reference to rainfall and/or sunshine. *Zero Credit:* • A reason with no year identified.
(c)	47, 72, 84, 94, 94, 101, 133, 134, 149, 155. Median $= \frac{94+101}{2} = 97 \cdot 5$ mm.	**Scale 10C (0, 3, 7, 10)** *Low Partial Credit:* • Effort at ordering data. • Median calculated as $\left(\frac{94+47}{2}\right) = 70 \cdot 5$. • Consistent Median from an incorrect list (without work). *High Partial Credit:* • All Data ordered. • Correct Median without list. • Correct Median with Sunshine data [173]. *Full Credit:* • Correct list and correct Median without work. *Misreading:* • Works with a decreasing list.

(d) **(i)**	$$\text{Mean} = \frac{\sum_1^{10} Sunshine\ Data}{10}$$ $$= \frac{1818}{10}$$ $$= 181{\cdot}8$$	**Scale 10C (0, 3, 7, 10)** *Low Partial Credit:* • Effort at adding data. • Division by 10. *High Partial Credit:* • Formula fully substituted without calculation. • Gets mean of the rainfall [=106·3]. *Full Credit:* • Correct answer without work.
(d) **(ii)**	$5\%\ of\ 181{\cdot}8 = 9{\cdot}09$ $+5\% = 190{\cdot}89$ hours $-5\% = 172{\cdot}71$ hours Years within: 2003, 2004, 2005	**Scale 5C (0, 2, 3, 5)** *Low Partial Credit:* • Any work of merit e.g. Identifies One year (without work). • Finds 5% of mean [Answer (d)(i)]. *High Partial Credit:* • Two of the years identified (with work). • Establishes [172·71, 190·89] or consistent. • Correct answers without work.
(e)	Rainfall σ = 33·46057381 $\sigma = 33{\cdot}5$	**Scale 5B (0, 2, 5)** *Partial Credit:* • Mean calculated as 106·3. • Calculates σ for sunshine data [32·1]. • **Note:** • Answer as 33, or 33·46 merits F[*].

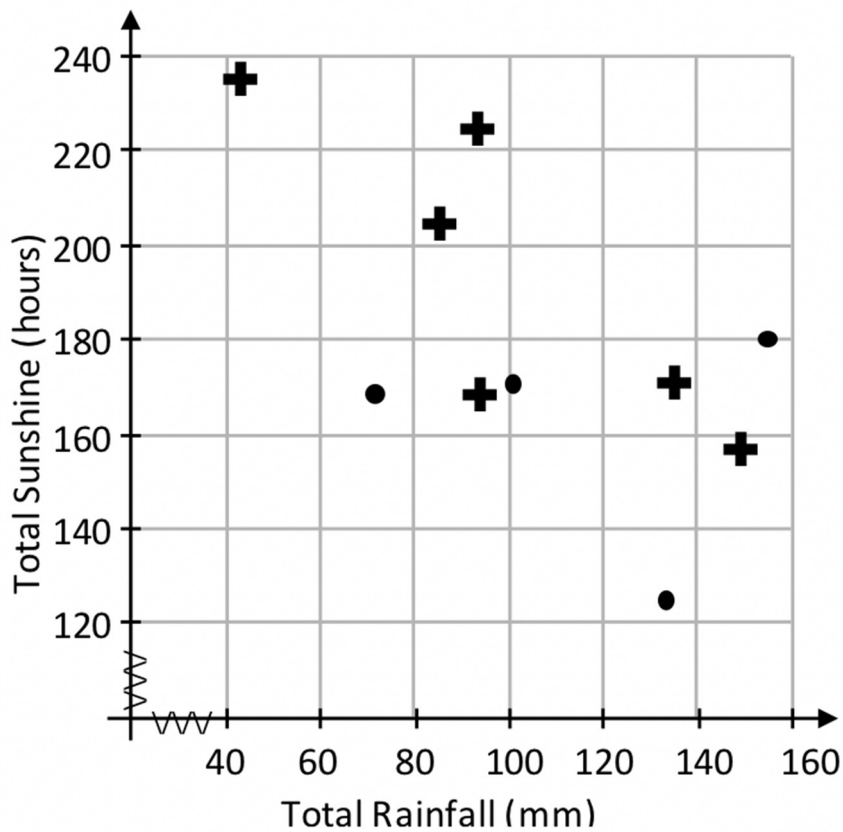| (f) (i)	Plots the remaining 6 pieces of data below.	**Scale 10C (0, 3, 7, 10)** *Low Partial Credit:* • One correct plot. *High Partial Credit:* • Four correct plots. **Tolerance**: Within the correct box.

(f) (ii)		**Scale 5A (0, 5)** *Full Credit:* • Correct box ticked and explanation is either: Correlation is negative and strong. or Correlation is negative and moderate. *Zero Credit:* • All other answers.

	Tick one box
0·6	
0·1	
−0·1	
−0·6	✓

Explanation: Correlation is negative and moderate or strong.

Q8	Model Solution – 50 Marks	Marking Notes
(a)	$\|PQ\|^2 = \|PR\|^2 + \|RQ\|^2$ $6{\cdot}5^2 = 3{\cdot}3^2 + \|RQ\|^2$ $42{\cdot}25 = 10{\cdot}89 + \|RQ\|^2$ $\|RQ\|^2 = 42{\cdot}25 - 10{\cdot}89$ $\|RQ\|^2 = 31{\cdot}36$ $\|RQ\| = \sqrt{31{\cdot}36}$ $\|RQ\| = 5{\cdot}6$ m	**Scale 10C (0, 3, 7, 10)** *Low Partial Credit:* • Correct relevant formula with some substitution. *High Partial Credit:* • Correct formula fully substituted. • Answer as $\sqrt{31{\cdot}36}$. • Correct answer without work.
(b)	$\sin\alpha = \dfrac{3{\cdot}3}{6{\cdot}5}$ $\alpha = \sin^{-1}\left(\dfrac{3{\cdot}3}{6{\cdot}5}\right)$ $\alpha = 30{\cdot}51$ $\alpha = 31°$	**Scale 10C (0, 3, 7, 10)** *Low Partial Credit:* • Correct trigonometric ratio with some correct or consistent substitution. *High Partial Credit:* • $\sin\alpha = \dfrac{3{\cdot}3}{6{\cdot}5}$ (or similar). • Finds $\|\angle QPR\| = 59°$ and stops. • Incorrect Calculator Mode (once only). $Rad = 1, \ Grad = 34.$
(c)	$\beta = 180° - 31° = 149°$	**Scale 5B (0, 2, 5)** *Partial Credit:* • Any work of merit. *Full Credit:* • Correct answer without work.

(d)		
	$a^2 = b^2 + c^2 - 2bc \cos A$	**Scale 15D (0 ,4, 7, 11, 15)**
	$\|RS\|^2 = 8^2 + 5{\cdot}6^2 - 2(8)(5{\cdot}6) \cos 149$	*Low Partial Credit:*
	$\|RS\|^2 = 64 + 31{\cdot}36 + 76{\cdot}80219014$	• Any work of merit to identify the correct side required.(Pilot Diagram)
	$\|RS\|^2 = 172{\cdot}16219014$	• Correct relevant formula with some correct or consistent substitution.
	$\|RS\| = \sqrt{172{\cdot}16219014}$	
	$\|RS\| = 13{\cdot}121$	*Mid Partial Credit:*
	$\|RS\| = 13$	• Two relevant variables correctly substituted into correct relevant formula and stops.
		High Partial Credit:
		• Fully correct substitution.
		• Correct answer without work (13).
		• Incorrect Calculator Mode (once only). $Rad = 115, \; Grad = 158$.
		Zero Credit:
		• Treats triangle as right angled/Sine Rule.
(e)		
	$\text{Arc } TS = 2\pi r \times \dfrac{\theta}{360}$	**Scale 5C (0, 2, 3, 5)**
	$= 2\pi(8) \times \dfrac{31}{360}$	*Low Partial Credit:*
	$= \dfrac{62\pi}{45}$	• Correct relevant formula with some correct or consistent substitution.
	$= 4{\cdot}3284$	*High Partial Credit:*
	$= 4{\cdot}3$	• Correct formula fully substituted $2\pi(8) \times \dfrac{31}{360}$
(f)		
	$\text{Area} = \pi r^2 \times \dfrac{\theta}{360}$	**Scale 5C (0, 2, 3, 5)**
	$= \pi(8)^2 \times \dfrac{31}{360}$	*Low Partial Credit:*
	$= \dfrac{248\pi}{45}$	• Correct relevant formula with some substitution.
	$= 17{\cdot}3136$	*High Partial Credit:*
	$= 17{\cdot}3$	• Correct formula fully substituted $\pi(8)^2 \times \dfrac{31}{360}$

Q9	Model Solution – 40 Marks	Marking Notes
(a) (i)	$$\text{volume} = \frac{4}{3}\pi r^3$$ $$= \frac{4}{3}\pi(0\cdot3)^3$$ $$= 0\cdot113097$$ $$=0\cdot113$$	**Scale 10B (0 ,5, 10)** *Partial Credit:* • Volume formula with radius substituted. *Full Credit:* • Correct answer without work. **Note 1:** • Answer: 0·113097 (without work). Merits F^* **Note: 2** Value(π) Volume Answer 3·14 0·11304 $\dfrac{22}{7}$ 0·1131428571
(a) (ii)	**(ii)** $$0\cdot113 \times 19\cdot3 = 2\cdot1809$$ $$= 2\cdot18$$	**Scale 5B (0 ,2, 5)** *Partial Credit:* • Any work of merit e.g. Indicates multiplication by 19·3. *Full Credit:* • Correct answer without work.
(a) (iii)	$$197\,\text{g} = 6\cdot02 \times 10^{23}\ \text{atoms}$$ $$1\,\text{g} = \frac{6\cdot02 \times 10^{23}}{197}$$ $$2\cdot18\,\text{g} = \frac{6\cdot02 \times 10^{23}}{197} \times 2\cdot18$$ $$= 6\cdot7 \times 10^{21}$$	**Scale 5C (0, 2, 3, 5)** *Low Partial Credit:* • Finds expression for atoms in 1 g. • Two incorrect operations and finishes. *High Partial Credit:* • Finds expression for atoms in 2·18 g. • One incorrect operation and finishes.

(b) **(i)**	$$\frac{1}{\sqrt{n}} = \frac{1}{\sqrt{1560}} = 0\cdot025318 = 2\cdot5$$	**Scale 5C (0, 2, 3, 5)** *Low Partial Credit:* - Writes $\frac{1}{\sqrt{n}}$. - Sets up work as $\sqrt{1560}$. *High Partial Credit:* - Correct formula fully substituted i.e. ($\frac{1}{\sqrt{1560}}$). - MOE formula substituted and calculated as $0\cdot025318$ without work. *Full Credit:* - Correct answer without work.
(b) **(ii)**	$$\frac{546}{1560} = 0\cdot35 = 35\%$$ 95% confidence interval = $$\left[\hat{p} - \frac{1}{\sqrt{n}} \;,\;\;\;\; \hat{p} + \frac{1}{\sqrt{n}} \right]$$ $$= [\, 35 - 2\cdot5 \;\;\;,\;\;\;\; 35 + 2\cdot5 \,]$$ $$= [\, 32\cdot5 \;\;,\;\; 37\cdot5 \,]$$	**Scale 5C (0, 2, 3, 5)** *Low Partial Credit:* - Work of merit e.g. writes answer from (b) (i) in this part. - Answer as $\frac{546}{1560}$. $\hat{p} \pm \frac{1}{\sqrt{n}}$ or $\hat{p} \pm 1\cdot96\sqrt{\frac{p(1-p)}{n}}$ *High Partial Credit:* - One boundary formed i.e. (35 + 2·5 or 35 − 2·5). - Correct answer without work.
(b) **(iii)**	$H_0: p = 40\%$ $H_1: p \neq 40\%$ $40\% \notin [\, 32\cdot5\% \;,\; 37\cdot5\% \,]$ Reject H_o: Percentage of viewers who like the show does not equal 40%	**Scale 10C (0, 3, 7, 10)** *Low Partial Credit:* **Any** of: $H_0, H_1,$ or C. I. correct. *High Partial Credit:* **All** of: $H_0, H_1,$ and C.I. corrrect. *Full Credit:* - Result of Hypothesis Test plus conclusion in context e.g. Reject the Null Hypothesis and hence reject the executive's claim.