Coimisiún na Scrúduithe Stáit
State Examinations Commission

Leaving Certificate 2017

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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Coimisiún na Scrúduithe Stáit
State Examinations Commission

Leaving Certificate Examination 2017

Model Solutions and Marking Scheme

Mathematics

Ordinary Level

Paper 1

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

(a)	10C
(b)	10C
(c)	5C

Question 2

(a)(i)	5B
(a)(ii)	5A
(b)	10D
(c)	5C

Question 3

(a)	10D
(b)	15D

Question 4

(a)	10C
(b)	15D

Question 5

(a)	10C
(b)	15D

Question 6

(a)	10C
(b)	15D

Section B

Question 7

(a)	5A
(b)	5C
(c)(i)	10C
(c)(ii)	5B
(c)(iii)	5B
(d)(i)	15C
(d)(ii)	5C

Question 8

(a)	5B
(b)	10C
(c)(i)	10C
(c)(ii)	5C
(c)(iii)	5B
(d)	10C

Question 9

(a)	10C
(b)	5B
(c)	10D
(d)	10C
(e)(i)	5C
(e)(ii)	10B
(e)(iii)	5C

Model Solutions & Marking Detailed 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)	$A = 30\,000(1 - 0{\cdot}15)^5$ $A = €13\,311{\cdot}16$ **Or** List Method 30000 25500 21675 18423·75 15660·19 13311·16	**Scale 10C (0, 4, 6, 10)** *Low Partial Credit:* • $30\,000 \times 15\%$ or equivalent • $0{\cdot}85$ • at least one correct substitution • correct formula written *High Partial Credit:* • $(0{\cdot}85)^5$ • 3 or 4 years correct by list method • fully correct substitution into formula but fails to finish • correct answer without work (13311)
(b)	$P(1 + 0{\cdot}03)^2 = 30\,000$ $P = €28\,277{\cdot}88$ **Or** List Method 30000 29126·21 28277·88 or 28277·87	**Scale 10C (0, 4, 6, 10)** *Low Partial Credit:* • $1{\cdot}03$ • at least 1 correct substitution • correct formula written • 2 unsuccessful efforts at trial and improvement *High Partial Credit:* • $\frac{30000}{1.03^2}$ • correct answer without work, 28277 or 28278
(c)	$26\,530{\cdot}2 = 25\,000(1 + i)^3$ $1 + i = 1{\cdot}02$ $i = 2\%$	**Scale 5C (0, 2, 3, 5)** *Low Partial Credit:* • $\frac{26530{\cdot}20}{25000}$ • $1530{\cdot}20$ • $\sqrt[3]{\ }$ • at least 1 correct substitution or correct formula written • correct answer without work *High Partial Credit:* • $1{\cdot}02$

Q2	Model Solution – 25 Marks	Marking Notes
(a) (i)	$(a = 3,\ b = -1)$	**Scale 5B (0, 2, 5)** *Partial Credit:* • $a = -1, \quad b = 3$ • one correct value only
(a) (ii)	Correct plot of $-1 + 2i$ on diagram	**Scale 5A (0, 5)**
(a) (iii)	$z_3 = \dfrac{(3 - i)(-1 - 2i)}{(-1 + 2i)(-1 - 2i)}$ $z_3 = -1 - i$	**Scale 10D (0, 4, 6, 8, 10)** *Low Partial Credit:* • at least 1 correct substitution *Mid Partial Credit:* • conjugate identified • some multiplication above and below by the same number, even if incorrect conjugate *High Partial Credit:* • correct multiplication using correct conjugate • answer not in correct form
(b)	$2z - 6(4 - 6i) = (-1 + i)(4 - 2i)$ $2z = 22 - 30i$ $z = 11 - 15i$	**Scale 5C (0, 2, 3, 5)** *Low Partial Credit:* • any correct multiplication *High Partial Credit:* • multiplication fully correct

Q3	Model Solution – 25 Marks	Marking Notes
(a)	$x = \frac{6 \pm \sqrt{36 - 4(3)(-8)}}{6}$ $x = 2{\cdot}91485 \text{ or } -0{\cdot}9485$ $x = 2{\cdot}9 \text{ or } -0{\cdot}9$	**Scale 10D (0, 4, 6, 8, 10)** *Low Partial Credit:* • correct roots formula • a, b, and c explicitly identified • attempt at factorising *Mid Partial Credit:* • formula fully substituted • $x = \frac{6 \pm \sqrt{-60}}{6}$ and stops or continues *High Partial Credit:* • one correct root • $x = \frac{6 \pm \sqrt{132}}{6}$ and stops
(b)	$\frac{dy}{dx} = 6x - 6 = 0$ $x = 1$ $y = -11$	**Scale 15D (0, 5, 7, 10, 15)** *Low Partial Credit:* • $\frac{dy}{dx}$ or $f'(x)$ *or* $f'(x) = 0$ • any correct differentiation • some work towards a graphical solution • correct answer without work *Mid Partial Credit:* • $6x - 6$ or $6x - 6 = 0$ *High Partial Credit:* • finds x value correctly **Note**: Accept correct turning point found graphically for full marks

Q4	Model Solution – 25 Marks	Marking Notes
(a)	$11x - 5(2x - 1) = 3(6 - x) + 3$ $x = 4$	**Scale 10C (0, 4, 6, 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)	$y = 2x - 5$ $x^2 + (2x - 5)^2 = 25$ $5x(x - 4) = 0$ $x = 0$ or $x = 4$ $y = -5$ or $y = 3$	**Scale 15D (0, 5, 7, 10, 15)** *Low Partial Credit:* • isolates one variable *Mid Partial Credit:* • substitution into quadratic *High Partial Credit:* • solve (2 values) for 1 variable • finds one correct couple from a quadratic **Note**: $(2x - 5)^2 = 4x^2 + 25$ and continues correctly merits MPC

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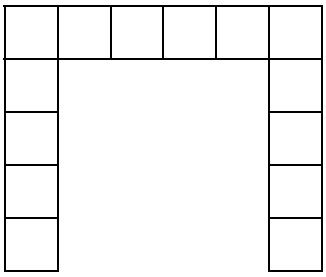
Q5	Model Solution – 25 Marks	Marking Notes
(a)	$A = \frac{3}{2}\begin{pmatrix}4 + 8 + 2[5\cdot8 + 7 + 6\cdot5 + 6 + \\ 4\cdot8 + 6 + 6\cdot5]\end{pmatrix}$ $A = 145\cdot8\ \text{m}^2$	**Scale 10C (0, 4, 6, 10)** *Low Partial Credit:* • correct relevant area formula with some substitution *High Partial Credit:* • formula fully substituted • uses Simpsons Rule and finishes correctly
(b)	$145\cdot6 = \frac{4}{2}(4 + 8 + 2[6\cdot4 + 6\cdot9 + 6 + x + 6\cdot2])$ $4x = 19\cdot6$ $x = 4\cdot9$	**Scale 15D (0, 5, 7, 10, 15)** *Low Partial Credit:* • correct relevant area formula with some substitution *Mid Partial Credit:* • Formula fully substituted *High Partial Credit:* • x isolated from formula • uses Simpsons Rule and finishes correctly

Q6	Model Solution – 25 Marks	Marking Notes
(a)	$150 + 0{\cdot}2(1000) + 0{\cdot}3(2000)$ €950 per week	**Scale 10C (0, 4, 6, 10)** *Low Partial Credit:* • $1000 \times 20\%$ or equivalent • 2000 *High Partial Credit:* • both commissions found, 200 and 600
(b)	$1160 - (150 + 200) = €810$ at 30% $\frac{810}{0{\cdot}3} = €2700$ higher sales $2700 + 1000 = €3700$ total sales **Or** 1160 – 950 = 210 210 = 30% 700 = 100% Total Sales = 3000 + 700 = €3700	**Scale 15D (0, 5, 7, 10, 15)** *Low Partial Credit:* • $1160 - 150$ • $1160 - 200$ *Mid Partial Credit:* • 810 • $\frac{x}{0{\cdot}3}$ *High Partial Credit:* • 2700

<table>
<tr><th>Q7</th><th>Model Solution – 50 Marks</th><th>Marking Notes</th></tr>
<tr><td>(a)</td><td>Pattern  4</td><td>Scale 5A (0, 5)</td></tr>
<tr><td>(b)</td><td><table><tr><th>Pattern number (n)</th><th>Number of Tiles</th></tr><tr><td>1</td><td>5</td></tr><tr><td>2</td><td>8</td></tr><tr><td>3</td><td>11</td></tr><tr><td>4</td><td>14</td></tr><tr><td>5</td><td>17</td></tr></table></td><td>Scale 5C (0, 2, 3, 5)
Low Partial Credit:
• 1 or 2 correct new entries

High Partial Credit:
• 3 correct or consistent new entries</td></tr>
<tr><td>(c)
(i)</td><td>$T_n = a + (n-1)d$
$T_n = 5 + (n-1)3$
$T_n = 3n + 2$

or

$p + q = 5$
$2p + q = 8$
$p = 3 \qquad q = 2$</td><td>Scale 10C (0, 4, 6, 10)
Low Partial Credit:
• T_n formula written with some substitution
• 1 or 2 relevant equations in p & q
• $d = 3$ or $a = 5$ written

High Partial Credit:
• T_n formula fully substituted
• value of p or value of q found

Note: Accept $3n + 2$ without work for full marks</td></tr>
</table>

(c) (ii)	$T_{20} = 62$	**Scale 5B (0, 2, 5)** *Partial Credit:* • formula with some substitution • listing of terms (>10) but T_{20} not identified or incorrectly identified **Note:** Accept correct answer without work
(c) (iii)	$3n + 2 = 290$ $n = 96$	**Scale 5B (0, 2, 5)** *Partial Credit:* • correct answer without work • equation (with formula) written • $3n + 2$ on its own • finds $T_{290} = 872$, but 872 without work is zero marks
(d) (i)	$S_n = \frac{n}{2}(10 + (n-1)3)$ $S_n = \frac{n}{2}(3n + 7)$ $S_n = \frac{3n^2 + 7n}{2}$	**Scale 15C (0, 6, 10, 15)** *Low Partial Credit:* • correct formula with some correct substitution • $a = 5$ and/or $d = 3$ *High Partial Credit:* • formula fully substituted
(d) (ii)	$S_{30} = \frac{3(30)^2+7(30)}{2}$ =1455 tiles	**Scale 5C (0, 2, 3, 5)** *Low Partial Credit:* • formula $= 1455$ • finds $S_n = 30$ • $a = 5$ and/or $d = 3$ • evidence of addition of terms in trial and improvement method *High Partial Credit:* • quadratic equation formed • substitutes correctly into either S_n formula

<table>
<tr><th>Q8</th><th>Model Solution – 45 Marks</th><th>Marking Notes</th></tr>
<tr><td>(a)</td><td>€2000</td><td>Scale 5B (0, 2, 5)
Partial Credit:
• $x = 0$</td></tr>
<tr><td>(b)</td><td>$275x - x^2 - 2000 = 8350$
$-x^2 + 275x - 10350 = 0$
$x = 45,\ \ x = 230$

$x = 230$ is not possible as production limit is 200

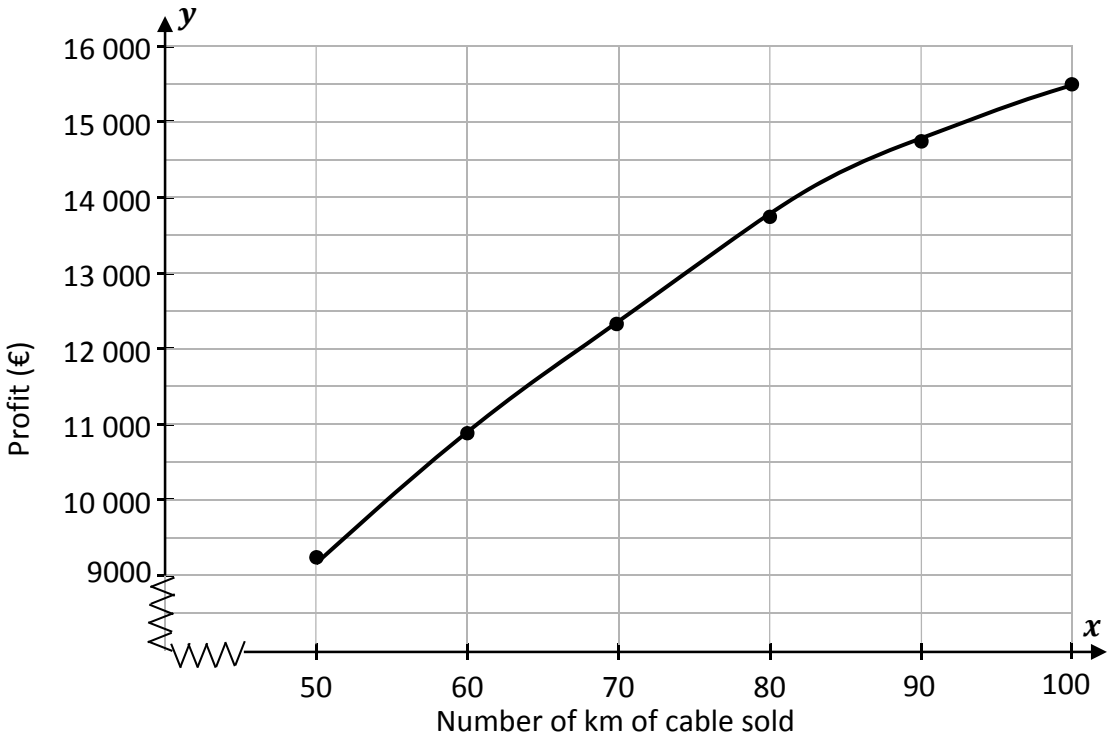
$x = 45$ km</td><td>Scale 10C (0, 4, 6, 10)
Low Partial Credit:
• quadratic equation written
• 45 without work

High Partial Credit:
• roots of quadratic

Note: 45 subbed in to get 8350 is full Marks</td></tr>
<tr><td>(c)
(i)</td><td><table><tr><td>50</td><td>60</td><td>70</td><td>80</td><td>90</td><td>100</td></tr><tr><td>9250</td><td>10 900</td><td>12 350</td><td>13 600</td><td>14 650</td><td>15 500</td></tr></table></td><td>Scale 10C (0, 4, 6, 10)
Low Partial Credit:
• 1 or 2 correct new entries

High Partial Credit:
• 3 or 4 correct new entries</td></tr>
</table>

(c)
(ii)



(c) **(ii)**	Graph above	**Scale 5C (0, 2, 3, 5)** *Low Partial Credit:* • 1, 2 or 3 correct plots • bar chart *High Partial Credit:* • 4 or 5 correct plots • 6 correct plots but not joined
(c) **(iii)**	Lower 55 Upper 83 (Lines to be shown on diagram)	**Scale 5B (0, 2, 5)** *Partial Credit:* • evidence of use of graph • one correct range found • correct answers without work
(d)	$\frac{dP}{dx} = 275 - 2x = 105$ $2x = 170$ $x = 85$	**Scale 10C (0, 4, 6, 10)** *Low Partial Credit:* • effort at calculus *High Partial Credit:* • correct differentiation

Q9	Model Solution – 55 Marks	Marking Notes
(a)	$male = 174{\cdot}87$ cm $female = 172{\cdot}98$ cm	**Scale 10C (0, 4, 6, 10)** *Low Partial Credit:* • substitution into either formula *High Partial Credit:* • one relevant height found **Note**: Correct answer without work, award full marks
(b)	$2{\cdot}3x + 65{\cdot}53 = 184$ $x = 51{\cdot}51$ cm	**Scale 5B (0, 2, 5)** *Partial Credit:* • equation formed
(c)	$2{\cdot}3(44{\cdot}2) + 65{\cdot}53 = 167{\cdot}19$ $171 - 167{\cdot}19 = 3{\cdot}81$ $\frac{3{\cdot}81}{171} \times 100 = 2{\cdot}228\%$ $2{\cdot}23\%$	**Scale 10D (0, 4, 6, 8, 10)** *Low Partial Credit:* • formula $= 167{\cdot}19$ • correct substitution into formula • correct answer no work *Mid Partial Credit:* • error found, $3{\cdot}81$ *High Partial Credit:* • % error formulated • $97{\cdot}77\%$ found
(d)	$2{\cdot}3x + 65{\cdot}53 = 2{\cdot}5x + 54{\cdot}13$ $0{\cdot}2x = 11{\cdot}4$ $x = 57$ cm --- *m*(57) ***or*** *f*(57) = 196·63 cm	**Scale 10C (0, 4, 6, 10)** *Low Partial Credit:* • Formulas equated *High Partial Credit:* • transpose completed • length of femur found (x) and stops

(e) **(i)**	$P = \frac{72{\cdot}5}{1{\cdot}6^3}$ $P = 17{\cdot}7$	**Scale 5C (0, 2, 3, 5)** *Low Partial Credit:* • some relevant substitution into formula *High Partial Credit:* • formula fully substituted
(e) **(ii)**	$Ph^3 = M$ $h = \sqrt[3]{\frac{M}{P}}$	**Scale 10B (0, 5, 10)** *Partial Credit:* • some relevant transpose
(e) **(iii)**	$13 = \frac{67{\cdot}5}{h^3}$ $h = 1{\cdot}7316$ $h = 1{\cdot}73$ **or** $h = \sqrt[3]{\frac{M}{P}}$ $h = \sqrt[3]{\frac{67{\cdot}5}{13}}$ $h = 1{\cdot}73$	**Scale 5C (0, 2, 3, 5)** *Low Partial Credit:* • some relevant substitution into formula • correct answer without work *High Partial Credit:* • formula fully substituted

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Coimisiún na Scrúduithe Stáit
State Examinations Commission

Leaving Certificate Examination 2017

Model Solutions and Marking Scheme

Mathematics

Ordinary Level

Paper 2

300 marks

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, 3, 5	0, 2, 3, 5	0, 2, 3, 4, 5	
10 mark scales	0, 10	0, 5, 10	0, 3, 7, 10	0, 4, 5, 7, 10	
15 mark scales	0, 15	0, 7, 15	0, 7, 10, 15	0, 5, 7, 9, 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

Question 1

(a)(i)	5B
(a)(ii)	5C
(b)(i) +(ii)	5C
(c)(i)	5B
(c)(ii)	5B

Question 2

(a)	5C
(b)(i)	5C
(b)(ii)	5C
(c)	10C

Question 3

(a)(i)	5C
(a)(ii)	5C
(b)	10C
(c)	5C

Question 4

(a)	10C
(b)(i)	5C
(b)(ii)	10D

Question 5

(a)(i)	15C
(a)(ii) +(iii)	5C
(b)	5B

Question 6

(a)	10D
(b)	15D

Section B

Question 7

(a)(i)	10B
(a)(ii)	5D
(b)(i)	10C
(b)(ii)	10B
(b)(iii)	10D
(c)(i) +(ii)	10C

Question 8

(a)	10C
(b)	10D
(c)(i)	5C
(c)(ii)	5C
(c)(iii)	5B
(c)(iv)	5C

Question 9

(a)(i)	5B
(a)(ii)	5C
(b)(i)	15C
(b)(ii)	10C
(b)(iii)	5B
(c)(i)	5C
(c)(ii)	5C
(c)(iii)	5C

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.
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.

Detailed marking notes

Model Solutions & Marking Notes

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

<table>
<tr><th>Q1</th><th>Model Solution – 25 Marks</th><th>Marking Notes</th></tr>
<tr><td>(a)
(i)</td><td>$65909 - 32290 = 33619$</td><td>Scale 5B (0, 3, 5)
Partial Credit:
• Indicates relevant subtraction.

Full Credit:
• Correct answer without work.</td></tr>
<tr><td>(a)
(ii)</td><td>$\mathrm{P(B))}= \frac{33619}{65909} = 0{\cdot}51(51{\cdot}01\%)$</td><td>Scale 5C (0, 2, 3, 5)
Low Partial Credit:
• Either #(E) or #(S) correct.
(Answer must be shown in fraction format).

High Partial Credit:
• $P(B) = \frac{33619}{65909}$

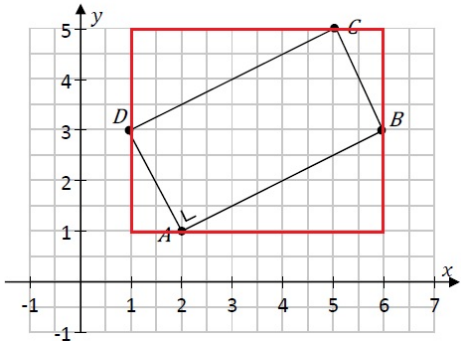
Full Credit:
• Correct answer without work.

Special Case
Without Work | Award
51% | F* Full Credit -1</td></tr>
</table>

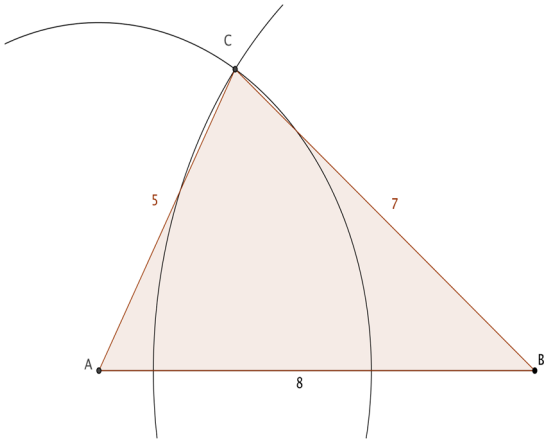
(b) (i) + (b) (ii)	$(0{\cdot}51)^3 = 0{\cdot}132651 = 0{\cdot}1327$ **or** $\left(\frac{33619}{65909}\right)^3 = 0{\cdot}1327150596 = 0{\cdot}1327$ **and** $(0{\cdot}51)^2(0{\cdot}49) = 0 \cdot 127449 = 0{\cdot}1274$ **or** $\left(\frac{33619}{65909}\right)^2 \left(\frac{32290}{65909}\right) = 0{\cdot}1274686717$ $= 0{\cdot}1275$	**Scale 5C (0, 2, 3, 5)** *Low Partial Credit:* • $(0{\cdot}51)^x$ • $0{\cdot}49$ *High Partial Credit:* • One correct answer. • $(0{\cdot}51)(0{\cdot}51)(0{\cdot}51)$ & $(0{\cdot}51)(0{\cdot}51)(0{\cdot}49)$. • Substantial work in both parts. *Full Credit:* • Correct answers without work.
(c) (i)	$1 - \sum_{\text{Monday}}^{\text{Sunday}}$ Probabilities $1 - (0{\cdot}14+0{\cdot}15+0{\cdot}18+0{\cdot}15+0{\cdot}12+0{\cdot}1)$ $=1 - 0{\cdot}84$ $=0{\cdot}16$	**Scale 5B (0, 3, 5)** *Partial Credit:* • Formulates addition of some probabilities. • 1 – (incorrect) Sum *Full Credit:* • Correct answer without work.
(c) (ii)	Tuesday Babies $=1300 \times 0{\cdot}16 = 208$	**Scale 5B (0, 3, 5)** *Partial Credit:* • Probability of (Tuesday) used. • Work of merit with 1300. *Full Credit:* • Correct answer without work.

Q2	Model Solution – 25 Marks	Marking Notes
(a)	$x^2+y^2=25$	**Scale 5C (0, 2, 3, 5)** *Low Partial Credit:* • Equation of circle formula with some substitution. e.g. $\mathbf{x^2+y^2}=$. • 25 or 5^2. *High Partial Credit:* • Equation of circle formula fully substituted. i.e. $x^2+y^2=5^2$
(b) **(i)**	$16+k^2=25$ $k=3$	**Scale 5C (0, 2, 3, 5)** *Low Partial Credit:* • (-4) or k substituted into equation of circle. *High Partial Credit:* • $(-4)^2+k^2=25$. • Leaves as $k^2=9$. • Correct answer without work.
(b) **(ii)**	AB is the diameter of the circle so the triangle is right-angled at P **or** $m_{PA}=3$ $m_{PB}=\frac{-1}{3}$ $m_{PA}\times m_{PB}=-1$ $\Longrightarrow PA \perp PB$	**Scale 5C (0, 2, 3, 5)** *Low Partial Credit:* • Correct relevant formula with some substitution. • AB is the diameter (but fails to draw conclusion). • Demonstrates understanding of a requirement to use slopes. e.g. $[m_1\times m_2=-1]$ • One correct slope, or length. *High Partial Credit:* • Both slopes correct but no conclusion. • Triangle ABP is right angled. *Zero Credit:* • Triangle drawn with P identified as right angled.

(c)	$A_{region} = A_{semi\text{-}circle} - A_{triangle}$ $A_{region} = \frac{1}{2}\pi 5^2 - \frac{1}{2}10(3)$ $A_{region} = 39{\cdot}2699 - 15$ $A_{region} = 24{\cdot}2699$ $A_{region} = 24{\cdot}27$	**Scale 10C (0, 3, 7, 10)** *Low Partial Credit:* • Area of circle or semi-circle formula with some substitution. • Area of triangle formula with some substitution. • Area =Area of semicircle –Area of triangle (or equivalent). *High Partial Credit:* • Both areas found. • Answer as $A = \frac{1}{2}\pi 5^2 - \frac{1}{2}10(3)$. Note: $\boldsymbol{\pi_{Cal} = 24{\cdot}27}$ $\boldsymbol{\pi_{3{\cdot}14} = 24{\cdot}25}$ $\boldsymbol{\pi_{\frac{22}{7}} = 24{\cdot}29}$

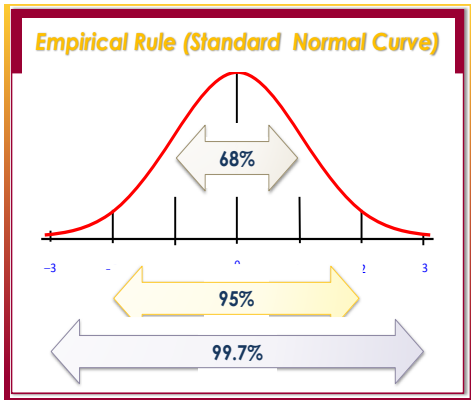
Q3	Model Solution – 25 Marks	Marking Notes
(a) **(i)**	$\|AD\| = \sqrt{1+4} = \sqrt{5}$	**Scale 5C (0, 2, 3, 5)** *Low Partial Credit:* • Correct relevant formula with some substitution. • Work with Pythagoras (check candidates diagram) *High Partial Credit:* • Distance formula fully substituted. • Pythagoras's fully substituted. *Zero Credit:* • Measurement from diagram (2·2).
(a) **(ii)**	$\|CD\| = \sqrt{16+4} = \sqrt{20}$ Area $= \sqrt{20} \times \sqrt{5}$ Area$=10$ or  	**Scale 5C (0, 2, 3, 5)** *Low Partial Credit:* • Area $= \|AD\| \times \|CD\|$. • Area $= A_{\text{Rectangle}} - A_{4\text{ Triangles}}$ • Correct relevant formula with some substitution. *High Partial Credit:* • Area of triangles calculated. • Area $= \sqrt{20} \times \sqrt{5}$. • Area $= 20 - (4+4+1+1)$. *Zero Credit:* • Measurement from diagram (2·2, 4·5). *Full Credit:* • Correct answer without work.
(b)	$m_{BC} = -2$ $y - 3 = -2(x - 6)$ $2x + y - 15 = 0$	**Scale 10C (0, 3, 7, 10)** *Low Partial Credit:* • Correct relevant formula with some substitution. *High Partial Credit:* • Eq. of line formula fully substituted. • One incorrect substitution followed by correct solution. **Note:** Accept $(\mathbf{-2x - y + 15 = 0})$

(c)	$\sin ABD = \frac{\sqrt{5}}{5}$ or $\cos ABD = \frac{\sqrt{20}}{5}$ or $\tan ABD = \frac{\sqrt{5}}{\sqrt{20}}$ Showing $\angle ABD = 26{\cdot}565$ $= 27°$	**Scale 5C (0, 2, 3, 5)** *Low Partial Credit:* • Any work of merit e.g. identifies $\angle ABD$. • Work of merit with correct trigonometric ratio. • Correct relevant formula with some substitution. *High Partial Credit:* • Sets up a correct trigonometric ratio. • Correct relevant formula fully substituted. *Misread* (−1): • Finds $\lvert\angle ADB\rvert$ correctly. **Note**: Rad=0·4636 Grad=29·5167

Q4	Model Solution – 25 Marks	Marking Notes
(a)		**Scale 10C (0, 3, 7, 10)** *Low Partial Credit:* • Pilot diagram drawn. • One correct length drawn. *High Partial Credit:* • TWO correct lengths drawn. • Construction correct without arcs (having checked length of sides). • Construction correct but vertices incorrectly named or omitted. *Full Credit:* • Correct construction with sides or vertices labelled correctly. **Note:** Tolerance $\pm$ 0·25 cm.
(b) **(i)**	$\text{Area} = 2k \times 2k$ $= 4k^2 \text{ cm}^2$	**Scale 5C (0, 2, 3, 5)** *Low Partial Credit:* • Area of square written as L × W (or similar). *High Partial Credit:* • Correct relevant formula fully substituted. *Full Credit:* • Correct answer without work.

(b) **(ii)**	$4k^2 = 20^2 + 20^2$ $k^2 = 200$ $k = 10\sqrt{2}$ $= 14{\cdot}14$ $Area = 4k^2 - \text{Area } \Delta$ $\text{Area} = 4\left(10\sqrt{2}\right)^2 - \frac{1}{2}(20)(20)$ $Area = 600(599{\cdot}7584)\ \text{cm}^2$	**Scale 10D (0, 4, 5, 7, 10)** *Low Partial Credit:* • Any use of Pythagoras's Theorem. • Area of Triangle Formula with some substitution. • Formulates for area using subtraction. *Mid Partial Credit:* • Value of k found. • Area of Triangle $= 200$. *High Partial Credit:* • Area of square and area of triangle found. **Note:** Accept correct rounding of answers.

<table>
<tr><th>Q5</th><th>Model Solution – 25 Marks</th><th>Marking Notes</th></tr>
<tr><td>(a)
(i)</td><td>
<table>
<tr><td>55</td><td>70</td><td>Given</td><td>100</td><td>115</td><td>130</td><td>145</td></tr>
</table>
</td><td>Scale 15C (0, 7, 10, 15)
Low Partial Credit:
• One correct new entry.
• Writes $\bar{x}=100$ or $\sigma=15$.
• Writes $\bar{x}$, σ, 2σ or 3σ on axis correctly.

High Partial Credit:
• Four correct new entries.</td></tr>
<tr><td>(a)
(ii)
+
(a)
(iii)</td><td> 

$p = 0{\cdot}95, (95\%), \left(\frac{95}{100}\right)$
and
$0{\cdot}68 \times 1200 = 816$</td><td>Scale 5C (0, 2, 3, 5)
Low Partial Credit:
• Shows some understanding of the Empirical Rule.
• Work of merit with 1200.

High Partial Credit:
• One correct answer.
[e.g. $p = 0{\cdot}95(95\%)$]
• Error in the use of the Empirical Rule.
[e.g. (a)(ii) 68% and (a)(iii) 95% of 1200 =1140]
• Substantial work in both parts.</td></tr>
<tr><td>(b)</td><td>$P = \frac{10 + (14 - 9)}{24} = \frac{15}{24}$
or
$P = \frac{10+9-4}{24} = \frac{15}{24}$,$(0{\cdot}625), 62{\cdot}5\%$
or
$P = \frac{10}{24} + \frac{5}{24} = \frac{15}{24}$</td><td>Scale 5B (0, 3, 5)
Partial Credit:
• Any relevant work towards creating at least one correct probability.
[e.g. $P = \frac{x}{24}$ $x \neq 15$]
• Answer as $10 + 5$.

Zero Credit:
• Answer as 15.

Full Credit:
• Correct answer without work.</td></tr>
</table>

Q6	Model Solution – 25 Marks	Marking Notes
(a)	$$\frac{x}{\sin 52} = \frac{10}{\sin 63}$$ $$x = \frac{10 \times \sin 52}{\sin 63}$$ $$x = 8{\cdot}84 \text{ cm}$$	**Scale 10D (0, 4, 5, 7, 10)** *Low Partial Credit:* • Any work of merit. [e.g. Third Angle = 52°] • Sine rule with some substitution. *Mid Partial Credit:* • Finds the length of the base side. (10·17) *High Partial Credit:* • Full correct substitution without calculation. • Incorrect calculator mode but otherwise correct. (once only) • Correct answer without work. Rad = 58·95392809 Grad = 8·721730163
(b)	$y^2 = 8{\cdot}5^2 + 10{\cdot}2^2 - 2(8{\cdot}5)(10{\cdot}2)\cos 53{\cdot}8$ $y^2 = 73{\cdot}87897723$ $y = 8{\cdot}595288083$ $y = 8{\cdot}60 \text{ cm}$	**Scale 15D (0, 5, 7, 9, 15)** *Low Partial Credit:* • Writes Cosine Rule correctly with some substitution. *Mid Partial Credit:* • Two variables correctly substituted into correct relevant formula. • $y^2 = 73{\cdot}878977$ without work and stops. *High Partial Credit:* • Fully correct substitution. • One incorrect substitution followed by correct calculation. • Incorrect calculator mode but otherwise correct. (once only) • Correct answer without work. *Zero Credit:* • Treating triangle as right-angled. **Note:** Rad = 18·34 Grad = 7·82

Q7	Model Solution – 55 Marks	Marking Notes
(a) (i)	$h = 2r$ $= 2(2{\cdot}25)$ $= 4{\cdot}5$ m	**Scale 10B (0, 5, 10)** *Partial Credit:* • Correct relationship identified. • $2{\cdot}25 \div 2$ • $h = d$ drawn on a diagram. *Full Credit:* • Correct answer without work.
(a) (ii)	$l^2 = h^2 + r^2$ $l^2 = (4{\cdot}5)^2 + (2{\cdot}25)^2$ $l^2 = 25{\cdot}3125$ $l = \sqrt{25{\cdot}3125}$ $= 5{\cdot}03$	**Scale 5D (0, 2, 3, 4, 5)** *Low Partial Credit:* • Some use of Pythagoras. • Work of merit. [e.g. Work with 2·25 / 4·5]. *Mid partial credit:* • Uses (5·03)to give: $(5{\cdot}03)^2 = (4{\cdot}5)^2 + (2{\cdot}25)^2$ *High Partial Credit:* • Pythagoras fully substituted. • Finishes with only one error. • Stops at $\sqrt{25{\cdot}3125}$
(b) (i)	$CSA = 14 \times \pi rl$ $= 14 \times \pi\ (2{\cdot}25)(5{\cdot}03)$ $= 497{\cdot}77$ m^2	**Scale 10C (0, 3, 7, 10)** *Low Partial Credit:* • CSA formula written with some correct substitution. • Work of merit. [e.g. Use of 2·25/5·03]. • Indicates multiplication by 14. *High Partial Credit:* • Fully correct substitution. • Finishes with only one error. • CSA of one cone calculated (35·55).

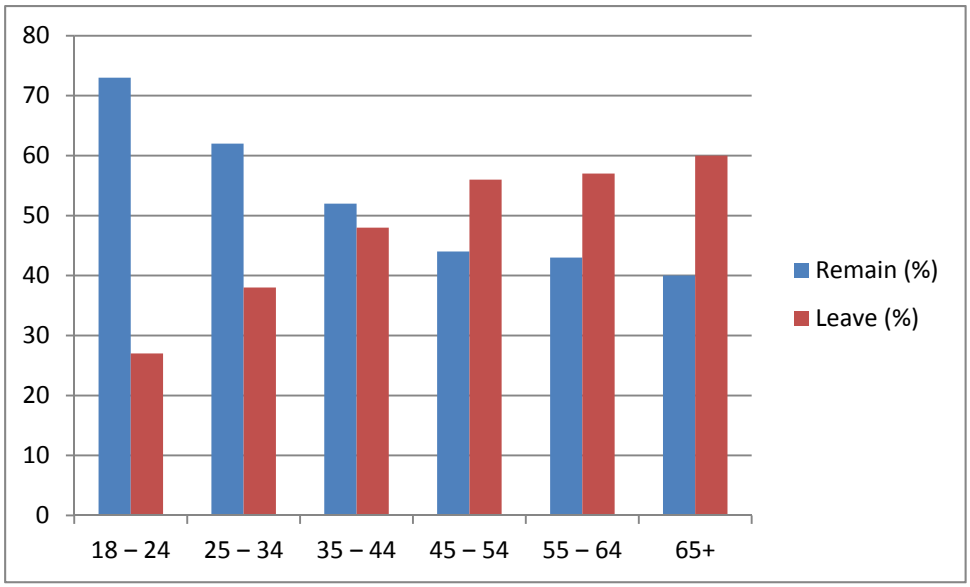
(b) **(ii)**	$$\text{No. of litres} = \frac{497{\cdot}77}{12{\cdot}25} = 40{\cdot}63428571$$ $$= 41$$	**Scale 10B (0, 5, 10)** *Partial Credit:* Works with answer to (b) (i). Works with $12{\cdot}25$.
(b) **(iii)**	Number of containers = $\frac{41}{5} = 8{\cdot}2 = 9$ $$\text{Cost} = 9 \times 110$$ $$= A\$\,990$$ $$= 990 \times €0{\cdot}68$$ $$= €673{\cdot}20$$ $$= €673$$	**Scale 10D (0, 4, 5, 7, 10)** *Low Partial Credit:* • Indicates answer as $\frac{(b)(ii)}{5}$ and stops . *Mid Partial Credit:* • Finds correct number of containers. (without work) *High Partial Credit:* Finds $A\$990$ or consistent equivalent. Finishes with only one error.
(c) **(i)** **+** **(c)** **(ii)**	$$Arc\ length = 2\pi r$$ $$= 2\pi\,(2{\cdot}25)$$ $$= 14{\cdot}14 \text{ m}$$ $$Arc\ length = \frac{\theta}{360} \times 2\pi r$$ $$\frac{\theta}{360} \times 2\pi\,(5{\cdot}03) = 14{\cdot}14$$ $$\theta = \frac{14{\cdot}14 \times 360}{2\pi\,(5{\cdot}03)}$$ $$\theta = 161°$$	**Scale 10C (0, 3, 7, 10)** *Low Partial Credit:* • Correct relevant formula written with some correct substitution. • Identifies r = $2{\cdot}25$ or CSA= $(35{\cdot}55)$. • Correct use of $360°$ *High Partial Credit:* • One correct. • Uses $\boldsymbol{l = r\theta}$ as degrees) ($\theta = 2{\cdot}8$). (1 rad $\approx 57{\cdot}296°$) • Substantial work in both parts.

Q8	Model Solution – 40 Marks	Marking Notes
(a)	$A = (1, -2)$ $B = (4, 2)$ $D = (6, -6)$ $E = (15, 6)$	**Scale 10C (0, 3, 7, 10)** *Low Partial Credit:* • ONE correct point. *High Partial Credit:* • THREE correct points. • All answers written consistently as $(y,\ x)$
(b)	$m_{AB} = \frac{4}{3}$ $m_{DE} = \frac{12}{9}$ **or** $\frac{4}{3}$ **Conclusion**: Parallel, or slopes are the same.	**Scale 10D (0, 4, 5, 7, 10)** *Low Partial Credit:* • Any mention of same slopes or similar. • Slope formula written with some relevant substitution. • Rise over Run (Written or indicated). *Mid Partial Credit:* • Slope formula fully substituted for one slope. • One correct slope. *High Partial Credit:* • Both slopes but no conclusion. • One error in substitution followed by correct calculation and consistent conclusion. *Full credit:* • Equal slopes and conclusion.
(c) **(i)**	$A = (1, -2)$ $B = (4, 2)$ $C = (4{\cdot}5, 0)$ $\downarrow$ $\downarrow$ $\downarrow$ $A = (0, 0)$ $B = (3, 4)$ $C = (3{\cdot}5, 2)$ $\text{Area} = \frac{1}{2}[(3)(2) - (3{\cdot}5)(4)]$ $\text{Area} = \frac{1}{2}\lvert(6) - (14)\rvert$ $= \frac{1}{2}\lvert(-8)\rvert$ $= 4$	**Scale 5C (0, 2, 3, 5)** *Low Partial Credit:* • Correct relevant formula with some correct/consistent substitution. • One point translated to $(0, 0)$. *High Partial Credit:* • Area= $\frac{1}{2}\lvert x_1y_2 - x_2y_1\rvert$ fully substituted with translated points. • Error in translation and area calculated correctly. • No translation but uses TWO of the points A, B, C and area calculated correctly. • One error in substitution followed by correct calculation.

(c) **(ii)**	$\lvert AB\rvert = \sqrt{3^2 + 4^2} = 5$ units	**Scale 5C (0, 2, 3, 5)** *Low Partial Credit:* • Correct relevant formula with some substitution. • Any work of merit indicated in this part. *High Partial Credit:* • Correct substitution without calculation. • One error in substitution followed by correct calculation. • Correct answer without work.
(c) **(iii)**	$\frac{15}{5} = 3 = k$	**Scale 5B (0, 3, 5)** *Partial Credit:* • Use of answer to part (c)(ii). • Scale factor formula written or indicated. • Attempts to calculate $\lvert AB\rvert$ in this part. *Full Credit:* • Correct answer without work.
(c) **(iv)**	Area $= 4 \times 3^2 = 36$ units^2	**Scale 5C (0, 2, 3, 5)** *Low Partial Credit:* • Work of merit with answer from (c)(iii). • Work of merit with answer from (c)(i). *High Partial Credit:* • Area as $3 \times 4 = 12$ or equivalent. *Full Credit:* • Correct answer without work.

Q9	Model Solution – 55 Marks	Marking Notes
(a) (i)	$33\,577\,342 - 33\,551\,983$ $= 25\,359$ invalid votes **or** Total – (leave + remain) = 25 359	**Scale 5B (0, 3, 5)** *Partial Credit:* • Relevant addition or subtraction indicated. *Full Credit:* • Correct answer without work. **Note:** If Correct answer not written in Table 1 Award **F.***
(a) (ii)	$\frac{17\,410\,742}{33\,551\,983} \times 100 = 51{\cdot}89\%$ $= 52(\%)$	**Scale 5C (0, 2, 3, 5)** *Low Partial Credit:* • Any correct element in relevant fraction. *High Partial Credit:* • Ignores or mishandles % calculation. [e.g. = 0·52% or 0·5189%]. *Full Credit:* • Correct answer without work.

(b)(i)



(b) **(i)**	Charts above:	**Scale 15C (0, 7, 10, 15)** *Low Partial Credit:* • Effort to draw a chart. [e.g. One data point displayed correctly] *High Partial Credit:* • One fully correct chart. • Two substantial charts shown. [e.g. Three or more data elements illustrated with scales and axes]

(b) (ii)

$$\bar{x} = \frac{\sum x}{n}$$

Remain			Leave
	73		27
	62		38
	52		48
	44		56
	43		57
	40		60
$\sum x$	314		286
$\frac{\sum x}{n}$	$\frac{314}{6}$		$\frac{286}{6}$
Mean	$52{\cdot}\dot{3}\%$		$47{\cdot}\dot{6}\%$
Mean	$52{\cdot}33\%$		$47{\cdot}67\%$

Remain mean $= 52{\cdot}33\%$
Leave mean $= 47{\cdot}67\%$

Scale 10C (0, 3, 7, 10)
Low Partial Credit:
- Indicates some relevant addition.
- Relevant formula with some correct substitution.

High Partial Credit:
- One mean correct.

Full Credit:
- Correct answer without work.

Special Case	
Without Work	**Award**
$52{\cdot}3$ and $47{\cdot}6$	F* *Full Credit* -1
$52{\cdot}3$ or $47{\cdot}6$	*High Partial*

(b) (iii)

The number of voters in each age group is not used in the calculation of the mean in (b)(ii). The mean is based on percentage data of voters in each age group and is therefore unreliable.

Scale 5B (0, 3, 5)
Partial Credit:
- The number of voters in each age group is not used.
- The mean values calculated in (b)(ii) are based on percentage data.

<table>
<tr>
<td>(c)
(i)</td>
<td>$\frac{1}{\sqrt{1200}} = 0{\cdot}0288675$

$= 2{\cdot}88675\%$
$= 3\%$</td>
<td>Scale 5C (0, 2, 3, 5)
Low Partial Credit:
• Writes $\frac{\mathbf{1}}{\sqrt{\mathbf{n}}}$.
• Sets up work as $\sqrt{1200}$

High Partial Credit:
• Correct formula fully substituted.
i.e. $(\frac{\mathbf{1}}{\sqrt{\mathbf{1200}}})$
• Answer as $0{\cdot}0288675$ or $(\frac{\sqrt{3}}{60})$ without work.

Full Credit:
• Correct answer without work.

Special Case
Without Work | Award
$2{\cdot}88675\%$ | F* Full Credit -1</td>
</tr>
<tr>
<td>(c)
(ii)</td>
<td>$\frac{578}{1200} \times 100 = 48{\cdot}16666$
$48 - 3 < \mathrm{p} < 48 + 3$

$45 < \mathrm{p} < 51$</td>
<td>Scale 5C (0, 2, 3, 5)
Low Partial Credit:
• Work of merit with margin of error from (c)(i).
• Answer as $\frac{\mathbf{578}}{\mathbf{1200}}$.
• $\hat{p} \pm \frac{1}{\sqrt{n}}$.

High Partial Credit:
• One boundary formed (48+3 or 48–3)
• Correct answer without work.
• Use of version of formula from HL.</td>
</tr>
<tr>
<td>(c)
(iii)</td>
<td>$H_0 = \mathrm{p} = 53\%$
$H_1 = \mathrm{p} \neq 53\%$
53% is not within the C. I. at (c)(ii)
$45{\cdot}17 < \mathrm{p} < 51{\cdot}17$
Reject H_0, Party claim is false</td>
<td>Scale 5C (0, 2, 3, 5)
Low Partial Credit:
• Null hypothesis stated.
• C. I. written.

High Partial Credit:
• Conclusion OK but not given in the context of the question. (Reject null hypothesis but no mention of party claim).</td>
</tr>
</table>

Marcanna breise as ucht freagairt trí Ghaeilge

(Bonus marks for answering through Irish)

Ba chóir marcanna de réir an ghnáthráta a bhronnadh ar iarrthóirí nach ngnóthaíonn níos mó ná 75% d'iomlán na marcanna don pháipéar. Ba chóir freisin an marc bónais sin a shlánú **síos**.

Déantar an cinneadh agus an ríomhaireacht faoin marc bónais i gcás gach páipéir ar leithligh.

Is é 5% an gnáthráta agus is é 300 iomlán na marcanna don pháipéar. Mar sin, bain úsáid as an ngnáthráta 5% i gcás iarrthóirí a ghnóthaíonn 225 marc nó níos lú, e.g. 198 marc × 5% = 9·9 ⇒ bónas = 9 marc.

Má ghnóthaíonn an t-iarrthóir níos mó ná 225 marc, ríomhtar an bónas de réir na foirmle [300 – bunmharc] × 15%, agus an marc bónais sin a shlánú **síos**. In ionad an ríomhaireacht sin a dhéanamh, is féidir úsáid a bhaint as an tábla thíos.

Bunmharc	Marc Bónais
226	11
227 – 233	10
234 – 240	9
241 – 246	8
247 – 253	7
254 – 260	6
261 – 266	5
267 – 273	4
274 – 280	3
281 – 286	2
287 – 293	1
294 – 300	0

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