



**Coimisiún na Scrúduithe Stáit**  
State Examinations Commission

**Leaving Certificate 2020**

**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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## 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, 3, 4, 5	0, 2, 3, 4, 5	
10 mark scales	0, 10	0, 5, 10	0, 4, 8, 10	0, 3, 5, 8, 10	
15 mark scales	0, 15	0, 7, 15	0, 5, 10, 15	0, 5, 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	(25 marks)
(a)(i)	10C
(a)(ii)	5D
(b)	10D
Question 2	(25 marks)
(a)	10C
(b)	15D
Question 3	(25 marks)
(a)(i)(ii)	10D
(a)(iii)	5C
(b)	10C
Question 4	(25 marks)
(a)(i)	10C
(a)(ii)	5C
(b)	10C
Question 5	(25 marks)
(a)	5C
(b)(i)	5C
(b)(ii)	10C
(b)(iii)	5C
Question 6	(25 marks)
(a)(i)	10C
(a)(ii)	5C
(a)(iii)	5C
(b)	5D

#### Section B

Question 7	(35 marks)
(a)(i)	10C
(a)(ii)	5C
(b)	5C
(c)(i)	5C
(c)(ii)	10C
Question 8	(55 marks)
(a)	5B
(b)(i)	5C
(b)(ii)	10C
(c)(i)	5C
(c)(ii)	5C
(c)(iii)	5C
(d)(i)	10C
(d)(ii)	10D
Question 9	(60 marks)
(a)	10C
(b)(i)	10B
(b)(ii)	5C
(b)(iii)	5C
(c)(i)	10C
(c)(ii)	5C
(d)(i)	10C
(d)(ii)	5C

## 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 is 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 then indicated in the right margin.

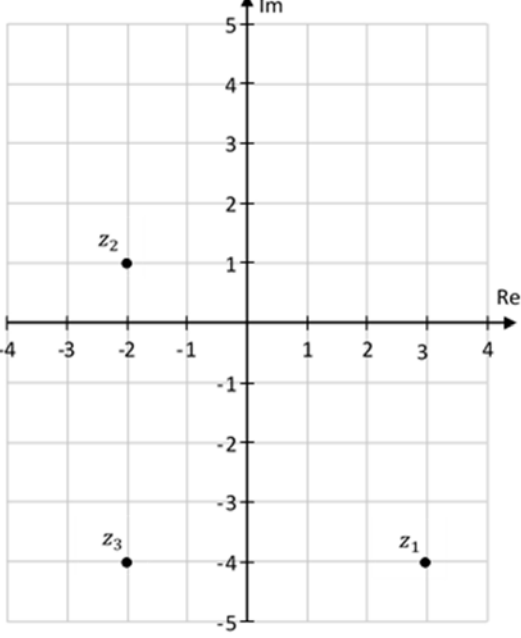
### Model Solutions & Detailed Marking Notes

**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.

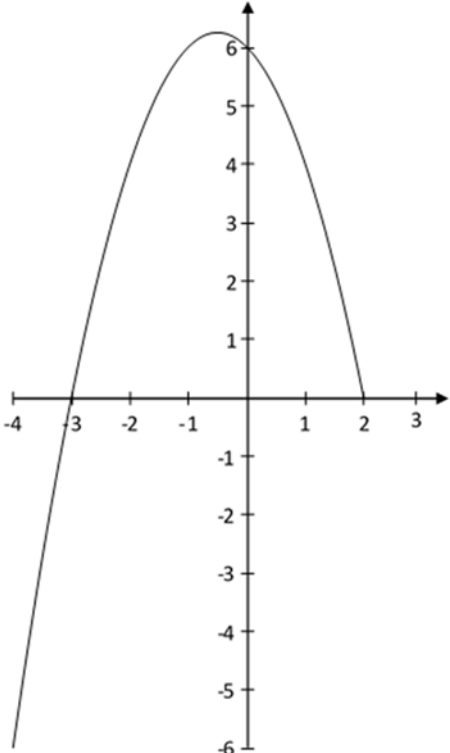
Q1	Model Solution – 25 Marks	Marking Notes
(a) (i)	$45 \times 12.60 + (350 - 200) \times 0.22$ $= \text{€}600$	<p><b>Scale 10C (0, 4, 8, 10)</b></p> <p><i>Low Partial Credit:</i>  <math>45 \times 12.60</math>  <math>(350) \times 0.22</math>  <math>(200) \times 0.22</math></p> <p><i>High Partial Credit:</i>  <math>45 \times 12.60 + (350 - 200) \times 0.22</math>            Either pay found</p> <p><b>Note:</b> Accept correct answer without work  <b>Note:</b> <math>45 \times 12.60 + (350) \times 0.22</math> finished correctly merits HPC</p>
(a) (ii)	$48 \times 12.60 + 3(12.6 \times 1.5) = 661.50$ $(713.20 - 661.50) \div 0.22 = \text{€}235.00$ $\text{€}235.00 + 200 = \text{€}435.00$	<p><b>Scale 5D (0, 2, 3, 4, 5)</b></p> <p><i>Low Partial Credit:</i>  <math>48 \times 12.60</math>  <math>3(12.6)</math></p> <p><i>Mid Partial Credit:</i>            Commission found or <math>\text{€}661.50</math></p> <p><i>High Partial Credit:</i>  <math>(713.20 - 661.50) \div 0.22</math></p>
(b)	$678 \times 0.20 + (713.20 - 678) \times 0.40$ $= \text{€}149.68$ $\text{€}149.68 - 26 = 123.68$ $\text{€}713.20 - 123.68$ $= \text{€}589.52 \text{ Net Income}$	<p><b>Scale 10D (0, 3, 5, 8, 10)</b></p> <p><i>Low Partial Credit:</i>  <math>678 \times 0.20</math>  <math>713.20 - 678</math></p> <p><i>Mid Partial Credit:</i>            Gross tax found</p> <p><i>High Partial Credit:</i>            Net tax found</p>



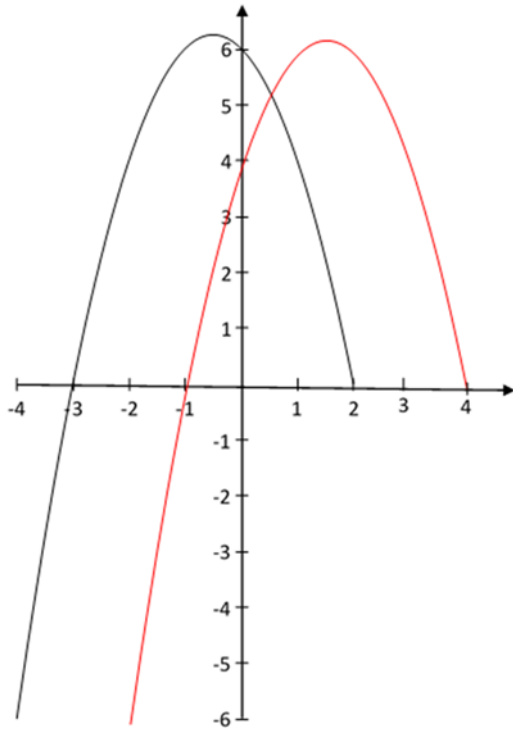
Q2	Model Solution – 25 Marks	Marking Notes
(a)	$12\left(\frac{9x-6}{2}\right) = 12\left(\frac{3x-14}{3}\right) + 12\left(\frac{9x}{4}\right)$ $6(9x-6) = 4(3x-14) + 3(9x)$ $54x-36 = 12x-56+27x$ $x = \frac{-20}{15} \text{ or } -\frac{4}{3}$	<p><b>Scale 10C (0, 4, 8, 10)</b></p> <p><i>Low Partial Credit:</i>  12 identified as common denominator  Some relevant multiplication  <math>4(3x-14) = 3(9x)</math> without CD</p> <p><i>High Partial Credit:</i>  <math>54x-36 = 12x-56+27x</math>  or equivalent</p>
(b)	$y = 3x - 4$ $4x^2 - 3x(3x - 4) = 4$ $4x^2 - 9x^2 + 12x - 4 = 0$ $-5x^2 + 12x - 4 = 0$ $5x^2 - 12x + 4 = 0$ $(5x - 2)(x - 2) = 0$ $x = \frac{2}{5} \text{ and } x = 2$ $y = 3\left(\frac{2}{5}\right) - 4 = \frac{-14}{5}$ $y = 3(2) - 4 = 2$ $\left(\frac{2}{5}, -\frac{14}{5}\right) \text{ and } (2, 2)$	<p><b>Scale 15D (0, 5, 7, 11,15)</b></p> <p><i>Low Partial Credit:</i>  x or y isolated</p> <p><i>Mid Partial Credit:</i>  <math>4x^2 - 3x(3x - 4) = 4</math>  or equivalent equation in one variable</p> <p><i>High Partial Credit:</i>  1 relevant value (root) found from quadratic</p>

Q3	Model Solution – 25 Marks	Marking Notes
<p>(a) (i) + (a) (ii)</p>	$z_3 = 2i(-2 + i) = -4i + 2i^2$ $-2 - 4i$ 	<p><b>Scale 10D (0, 3, 5, 8, 10)</b>  <b>Note:</b> 4 items (find <math>z_3</math> and 3 plots)</p> <p><i>Low Partial Credit:</i>  One correct item  (correct plot for incorrect <math>z_3</math>) or  (<math>z_1</math> plotted correctly) or  (<math>z_2</math> plotted correctly) or  (<math>z_3</math> correct but with incorrect plot)</p> <p><i>Mid Partial Credit:</i>  2 correct items</p> <p><i>High Partial Credit:</i>  3 correct items</p>
<p>(a) (iii)</p>	$ z_1  = \sqrt{9 + 16} = 5$	<p><b>Scale 5C (0, 3, 4, 5)</b>  <i>Low Partial Credit:</i>  <math> z_1 </math> formula</p> <p><i>High Partial Credit:</i>  Formula fully substituted</p>
<p>(b)</p>	$z_4 = \frac{(29 + 3i)(3 + 4i)}{(3 - 4i)(3 + 4i)}$ $= \frac{87 + 116i + 9i + 12i^2}{9 - 16i^2}$ $= \frac{75 + 125i}{25}$ $= 3 + 5i$	<p><b>Scale 10C (0, 4, 8, 10)</b>  <i>Low Partial Credit:</i>  Some correct substitution  Conjugate identified  Some multiplication above and below by  same number, even if incorrect conjugate</p> <p><i>High Partial Credit:</i>  <math display="block">\frac{(29 + 3i)(3 + 4i)}{(3 - 4i)(3 + 4i)}</math></p>

Q4	Model Solution – 25 Marks	Marking Notes
(a) (i)	$\frac{10\,000\,000}{3 \cdot 28^2} = 929506.2463$ $= 930\,000 \text{ m}^2$ $9.3 \times 10^5$	<p><b>Scale 10C (0, 4, 8, 10)</b></p> <p><i>Low Partial Credit:</i>  <math>10\,000\,000 \div 3 \cdot 28</math> or equivalent  <math>10\,000\,000 \times 3 \cdot 28^2</math></p> <p><i>High Partial Credit:</i>  <math>10\,000\,000 \div 3 \cdot 28^2</math></p>
(a) (ii)	$\frac{930\,000}{5}$ $= 186\,000 \text{ litres}$ $186\,000 \div 25$ $= 7440 \text{ tins}$	<p><b>Scale 5C (0, 3, 4, 5)</b></p> <p><i>Low Partial Credit:</i>  Relevant use of answer (a)(i)</p> <p><i>High Partial Credit:</i>  Incorrect litres <math>\div 25</math> correctly</p>
(b)	$2^{9x-1} = (2^3)^{2x}$ $2^{9x-1} = 2^{6x}$ $\Rightarrow 9x - 1 = 6x$ $\Rightarrow x = \frac{1}{3}$	<p><b>Scale 10C (0, 4, 8, 10)</b></p> <p><i>Low Partial Credit:</i>  <math>2^3</math> or <math>2^{6x}</math>  List of powers of 2</p> <p><i>High Partial Credit:</i>  Equation in <math>x</math> (Indices handled correctly)</p>

Q5	Model Solution – 25 Marks	Marking Notes																
(a)	$(x + 1)(x - 4) = 0$ $x = -1 \quad \text{or} \quad x = 4$ <p>Or Formula</p> $x = \frac{3 \pm \sqrt{25}}{2}$ $x = -1 \quad \text{or} \quad x = 4$	<p><b>Scale 5C (0, 3, 4, 5)</b></p> <p><i>Low Partial Credit:</i> Correct roots formula <math>a</math> or <math>b</math> or <math>c</math> explicitly identified Effort at factorising Correct answer without work</p> <p><i>High Partial Credit:</i> Correct factors 1 correct root <math>x = \frac{3 \pm \sqrt{25}}{2}</math> and stops</p>																
(b) (i)	<table border="1" data-bbox="252 797 810 920"> <tr> <td><math>x</math></td> <td>-4</td> <td>-3</td> <td>-2</td> <td>-1</td> <td>0</td> <td>1</td> <td>2</td> </tr> <tr> <td><math>f(x)</math></td> <td>-6</td> <td>0</td> <td>4</td> <td>6</td> <td>6</td> <td>4</td> <td>0</td> </tr> </table>	$x$	-4	-3	-2	-1	0	1	2	$f(x)$	-6	0	4	6	6	4	0	<p><b>Scale 5C (0, 3, 4, 5)</b></p> <p><i>Low Partial Credit:</i> One correct table entry</p> <p><i>High Partial Credit:</i> Three correct table entries</p>
$x$	-4	-3	-2	-1	0	1	2											
$f(x)$	-6	0	4	6	6	4	0											
(b) (ii)		<p><b>Scale 10C (0, 4, 8, 10)</b></p> <p><i>Low Partial Credit:</i> One correct plot from table entries</p> <p><i>High Partial Credit:</i> Three correct plots from table entries with some join</p>																

(b)  
(iii)



**Scale 5C (0, 3, 4, 5)**

*Low Partial Credit:*

One correct point or table entry or plot for  $g(x)$

*High Partial Credit:*

Three correct points or table entries or plots for  $g(x)$

Q6	Model Solution – 25 Marks	Marking Notes
(a) (i)	$f'(x) = 12x^2 - 6x + 1$	<p><b>Scale 10C (0, 4, 8, 10)</b>  <i>Low Partial Credit:</i>            1 term [other than <math>-7</math> (see note)] correctly differentiated</p> <p><i>High Partial Credit:</i>            2 terms correctly differentiated</p> <p><b>Note:</b> differentiation of independent term must be explicit for marks to be awarded            i.e. <math>f'(-7) = 0</math></p>
(a) (ii)	$12(1)^2 - 6(1) + 1 = 7 \text{ (Slope)}$	<p><b>Scale 5C (0, 3, 4, 5)</b>  <i>Low Partial Credit:</i>            Any substitution into candidates <math>f'(x)</math>  <math>f'(1)</math> or equivalent written</p> <p><i>High Partial Credit:</i>  <math>f'(-1)</math> fully substituted</p>
(a) (iii)	$y + 5 = 7(x - 1)$ $7x - y - 12 = 0$	<p><b>Scale 5C (0, 3, 4, 5)</b>  <i>Low Partial Credit:</i>            Eq. of line formula with some substitution</p> <p><i>High Partial Credit:</i>            Eq. of line formula fully substituted with            (1, 5) but not candidates answer from (a)(ii)</p>
(b)	$g(2) = 2(2)^2 + p(2) + q$ $8 + 2p + q = 6$ $2p + q = -2$ $g'(3) = 4(3) + p = 9$ $\Rightarrow p = -3$ <p>Sub <math>p = -3</math></p> $\Rightarrow 2(-3) + q = -2$ $q = 4$ $p = -3 \quad q = 4$	<p><b>Scale 5D (0, 2, 3, 4, 5)</b>  <i>Low Partial Credit:</i>  <math>g'(x)</math> found  <math>g(2)</math> found</p> <p><i>Mid Partial Credit:</i>  <math>g'(x)</math> and <math>g(2)</math> found  <math>2p + q = -2</math></p> <p><i>High Partial Credit:</i>  <math>p</math> found</p>

### Section B

Q7	Model Solution – 35 Marks	Marking Notes
(a) (i)	$443.66 \times 12 \times 3 = \text{€}15\,971.76$	<p><b>Scale 10C (0, 4, 8, 10)</b>  <i>Low Partial Credit:</i>            Some relevant substitution into formula</p> <p><i>High Partial Credit:</i>            Formula fully substituted</p>
(a) (ii)	$\frac{15971.76}{12000} \times 100 = 133.09 = 133.1\%$	<p><b>Scale 5C (0, 3, 4, 5)</b>  <i>Low Partial Credit:</i>            Some relevant substitution into formula</p> <p><i>High Partial Credit:</i>            Formula fully substituted</p>
(b)	$(1 + r)^3 = 1.331$ $1 + r = 1.1$ $r = 0.1 = 10\%$	<p><b>Scale 5C (0, 3, 4, 5)</b>  <i>Low Partial Credit:</i>            Some relevant substitution into formula</p> <p><i>High Partial Credit:</i>            Formula fully substituted</p>
(c) (i)	$32000(0.8)^3 = \text{€}16\,384$	<p><b>Scale 5C (0, 3, 4, 5)</b>  <i>Low Partial Credit:</i>            Some relevant substitution into formula</p> <p><i>High Partial Credit:</i>            Formula fully substituted</p>
(c) (ii)	$x(0.8)^3 = 17920$ $x = \frac{17920}{0.8^3} = \text{€}35\,000$	<p><b>Scale 10C (0, 4, 8, 10)</b>  <i>Low Partial Credit:</i>            Some relevant substitution into formula</p> <p><i>High Partial Credit:</i>            Formula fully substituted (<math>x</math> isolated)</p>

Q8	Model Solution – 55 Marks	Marking Notes
(a)	$h(0) = \frac{3}{5} \text{ m}$	<p><b>Scale 5B (0, 2, 5)</b>  <i>Partial Credit:</i>  <math>h(0)</math> indicated and stops</p>
(b) (i)	$\frac{1}{60}(12)^2 - \frac{1}{4}(12) + \frac{3}{5} = 0$ $0 = 0$	<p><b>Scale 5C (0, 3, 4, 5)</b>  <i>Low Partial Credit:</i>  Some relevant substitution into formula</p> <p><i>High Partial Credit:</i>  Formula fully substituted</p>
(b) (ii)	$60\left[\frac{1}{60}x^2 - \frac{1}{4}x + \frac{3}{5} = 0\right]$ $x^2 - 15x + 36 = 0$ $(x - 3)(x - 12) = 0$ $x = 3 \text{ m}$	<p><b>Scale 10C (0, 4, 8, 10)</b>  <i>Low Partial Credit:</i>  <math>h(x) = 0</math></p> <p><i>High Partial Credit:</i>  Function factorised correctly  Division of function by <math>(x - 3)</math> indicated</p>
(c) (i)	$h'(x) = \frac{1}{30}x - \frac{1}{4}$	<p><b>Scale 5C (0, 3, 4, 5)</b>  <i>Low Partial Credit:</i>  1 term [other than <math>\frac{3}{5}</math> (see note)] correctly differentiated</p> <p><i>High Partial Credit:</i>  2 terms correctly differentiated</p> <p><b>Note:</b> differentiation of independent term must be explicit for marks to be awarded  i.e. <math>f'\left(\frac{3}{5}\right) = 0</math></p>



<p>(c) (ii)</p>	$\frac{1}{30}x - \frac{1}{4} = 0$ $x = \frac{30}{4} = \frac{15}{2} \text{ m}$	<p><b>Scale 5C (0, 3, 4, 5)</b>  <i>Low Partial Credit:</i>  <math>f'(x) = 0</math> explicit</p> <p><i>High Partial Credit:</i>  <math>\frac{1}{30}x - \frac{1}{4} = 0</math></p>
<p>(c) (iii)</p>	$h(7.5) = \frac{1}{60}(7.5)^2 - \frac{1}{4}(7.5) + \frac{3}{5}$ $= \frac{27}{80} \text{ m}$	<p><b>Scale 5C (0, 3, 4, 5)</b>  <i>Low Partial Credit:</i>  Some substitution into <math>h(x)</math></p> <p><i>High Partial Credit:</i>  <math>h(x)</math> fully substituted with candidates value from (c)(ii)</p>

<p><b>(d)</b> <b>(i)</b></p>	$\frac{29.33 - 28.5}{28.5} \times 100 = 2.9\%$ $\frac{30.68 - 29.33}{29.33} \times 100 = 4.6\%$	<p><b>Scale 10C (0, 4, 8, 10)</b>  <i>Low Partial Credit:</i>  Relevant use of question data to formulate a percentage</p> <p><i>High Partial Credit:</i>  One correct percentage found</p>
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<p><b>(d)</b> <b>(ii)</b></p>	$\frac{x - 25.01}{25.01} \times 100 = 14.7$ $\Rightarrow x = 28.686$ $\frac{y - 28.686}{28.686} \times 100 = 2.91$ $\Rightarrow y = 29.518$ $\frac{z - 29.518}{29.518} \times 100 = 4.6$ $\Rightarrow z = 30.876$ <p>Total =  <math>25.01 + 28.686 + 29.518 + 30.876</math>  <math>= 1:54.09</math></p> <p>Difference = <math>1:54.09 - 1:53.36</math>  <math>= 0.73</math> Seconds</p>	<p><b>Scale 10D (0, 3, 5, 8, 10)</b>  <i>Low Partial Credit:</i>  50 – 100 m split time formulated using 25.01 and 14.7%</p> <p><i>Mid Partial Credit:</i>  One correct split time found</p> <p><i>High Partial Credit:</i>  Three correct split times found</p>
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Race Section	Split Time (secs)	Percentage Increase
0 – 50 m	25.01	
50 – 100 m	28.686	14.7%
100 – 150 m	29.518	2.9%
150 – 200 m	30.876	4.6%
<b>Total</b>	1: 54: 09	

Q9	Model Solution – 60 Marks	Marking Notes
(a)	$3, 7, 11, 15, 19, 23$	<p><b>Scale 10C (0, 4, 8, 10)</b>  <i>Low Partial Credit:</i>            One correct or consistent table entry</p> <p><i>High Partial Credit:</i>            Three correct or consistent table entries</p>
(b) (i)	$39$	<p><b>Scale 10B (0, 5, 10)</b>  <i>Partial Credit:</i>            Evidence of counting beyond <math>T_6</math>            Note: Accept correct answer without work</p>
(b) (ii)	$T_n = 3 + (n - 1)4$ $T_n = 4n - 1$	<p><b>Scale 5C (0, 3, 4, 5)</b>  <i>Low Partial Credit:</i>  <math>T_n</math> formula written</p> <p><i>High Partial Credit:</i>            Formula with some substitution</p>
(b) (iii)	$4n - 1 = 147$ $n = 37$	<p><b>Scale 5C (0, 3, 4, 5)</b>  <i>Low Partial Credit:</i>  <math>T_n</math> formula written</p> <p><i>High Partial Credit:</i>            Formula fully substituted</p>

<p>(c) (i)</p>	$S_n = \frac{n}{2}[6 + (n-1)4]$ $= \frac{n}{2}[4n + 2]$ $S_n = 2n^2 + n$	<p><b>Scale 10C (0, 4, 8, 10)</b>  <i>Low Partial Credit:</i>  <math>S_n</math> formula written</p> <p><i>High Partial Credit:</i>  Formula with some substitution</p>
<p>(c) (ii)</p>	$2n^2 + n = 820$ $2n^2 + n - 820 = 0$ $(2n + 41)(n - 20) = 0$ $n = 20 \text{ patterns}$	<p><b>Scale 5C (0, 3, 4, 5)</b>  <i>Low Partial Credit:</i>  <math>S_n</math> formula written  <math>S_n = 820</math>  Evidence of counting of sums</p> <p><i>High Partial Credit:</i>  Quadratic equation factorised</p> <p><b>Note:</b> Accept correct answer without work</p>
<p>(d) (i)</p>	<p>1, 3, 5, 7, 9, 11</p>	<p><b>Scale 10C (0, 4, 8, 10)</b>  <i>Low Partial Credit:</i>  One correct or consistent table entry</p> <p><i>High Partial Credit:</i>  Three correct or consistent table entries</p>
<p>(d) (ii)</p>	$4\sqrt{3} + 3(4\sqrt{3}) + 5(4\sqrt{3}) + 7(4\sqrt{3}) + \dots$ $= 4\sqrt{3}(1 + 3 + 5 + 7 + \dots)$ $= 4\sqrt{3}(S_{15}) \text{ where } a = 1 \text{ and } d = 2$ $= 4\sqrt{3} \left[ \frac{15}{2} (2 + 14 \times 2) \right]$ $= 4\sqrt{3} [7.5 \times 30]$ $= 1558.845727 = 1559 \text{ cm}^2$	<p><b>Scale 5C (0, 3, 4, 5)</b>  <i>Low Partial Credit:</i>  At least 3 terms of AP identified  <math>S_n</math> formula written</p> <p><i>High Partial Credit:</i>  Formula fully substituted</p>

**Mathematics**

**Ordinary Level**

**Paper 2**

## 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, 3, 4, 5	0, 2, 3, 4, 5	
10 mark scales	0, 10	0, 5, 10	0, 4, 8, 10	0, 3, 15, 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 (25 marks)

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

##### Question 2 (25 marks)

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

##### Question 3 (25 marks)

- (a)(i) 5C
- (a)(ii) 5C
- (a)(iii) 5C
- (b)(i) 5B
- (b)(ii) 5C

##### Question 4 (25 marks)

- (a)(i) 10B
- (a)(ii) 5D
- (b) 10D

##### Question 5 (25 marks)

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

##### Question 6 (25 marks)

- (a) 20D
- (b) 5C

#### Section B

##### Question 7 (55 marks)

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

##### Question 8 (55 marks)

- (a)(i) 5C
- (a)(ii) 10C
- (a)(iii) 5C
- (b)(i) 5B
- (b)(ii) 5C
- (b)(iii) 5A
- (b)(iv) 10D
- (b)(v) 10D

##### Question 9 (40 marks)

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

### 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)	$4 \times 6 \times 8 = 192$ available	<b>Scale 5C (0, 3, 4, 5)</b> <i>Low Partial Credit:</i> Work of merit <ul style="list-style-type: none"><li>• Indication of multiplication involving any two of 4, 6, and 8</li></ul> <i>High Partial Credit:</i> Significant work <ul style="list-style-type: none"><li>• Any three numbers multiplied which include any two of 4, 6, and 8</li></ul> <i>Full Credit:</i> <ul style="list-style-type: none"><li>• Correct answer without supporting work</li></ul>
(a) (ii)	$4 \times 6 \times x = 120$ $x = \frac{120}{24} = 5$ desserts	<b>Scale 10C (0, 4, 8, 10)</b> <i>Low Partial Credit:</i> Work of merit <ul style="list-style-type: none"><li>• <math>4 \times 6</math> indicated</li></ul> <i>High Partial Credit:</i> Significant work <ul style="list-style-type: none"><li>• Answer as <math>4 \times 6 \times x = 120</math></li></ul>



<p>(b) (i)</p>	$\frac{7}{8} \times \frac{7}{8} \times \frac{7}{8} \times \frac{1}{8} = \frac{343}{4096} \text{ or } 0.08374$	<p><b>Scale 5C (0, 3, 4, 5)</b>  <i>Low Partial Credit:</i>  Work of merit.  <ul style="list-style-type: none"> <li>Probability as <math>\frac{1}{8}</math> or <math>\frac{7}{8}</math></li> </ul>   <i>High Partial Credit:</i>  Significant work  <ul style="list-style-type: none"> <li><math>\frac{7}{8} \times \frac{7}{8} \times \frac{7}{8} \times \frac{1}{8}</math> and stops</li> </ul>   <b>Note:</b> Treat <math>\frac{1}{8} \times \frac{1}{8} \times \frac{1}{8} \times \frac{7}{8}</math> and continues correctly as <i>Full Credit</i> (-1)    <i>Full Credit:</i>  <ul style="list-style-type: none"> <li>Correct answer without supporting work</li> </ul> </p>
<p>(b) (ii)</p>	$3 \left( \frac{1}{8} \times \frac{1}{8} \times \frac{7}{8} \right) = \frac{21}{512} \text{ or } 0.04101$	<p><b>Scale 5C (0, 3, 4, 5)</b>  <i>Low Partial Credit:</i>  Work of merit  <ul style="list-style-type: none"> <li><math>\frac{1}{8} \times \frac{7}{8}</math> or <math>\frac{1}{8} \times \frac{1}{8}</math> in any way</li> </ul>   <i>High Partial Credit:</i>  Significant work  <ul style="list-style-type: none"> <li><math>3 \left( \frac{1}{8} \times \frac{1}{8} \times \frac{7}{8} \right)</math> or <math>\left( \frac{1}{8} \times \frac{1}{8} \times \frac{7}{8} \right) = \frac{7}{512}</math></li> </ul>   <i>Full Credit:</i>  <ul style="list-style-type: none"> <li>Correct answer without supporting work</li> </ul> </p>

Q2	Model Solution – 25 Marks	Marking Notes
(a)	$ AB  = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$ $= \sqrt{(-2 - 4)^2 + (2 - 6)^2}$ $= \sqrt{36 + 16}$ $= \sqrt{52}$ $(= 2\sqrt{13})$	<p><b>Scale 10C(0, 4, 8, 10)</b></p> <p><i>Low Partial Credit:</i></p> <ul style="list-style-type: none"> <li>• Formula with some substitution</li> </ul> <p><i>High Partial Credit:</i></p> <ul style="list-style-type: none"> <li>• Formula fully substituted</li> <li>• Incorrect substitution into formula and completed correctly</li> </ul> <p><b>Note:</b> Accept <math>1\sqrt{52}</math> or <math>\sqrt{52}</math> for full marks</p>
(b) (i)	$\text{Mid pt} = \left( \frac{x_1 + x_2}{2}, \frac{y_1 + y_2}{2} \right)$ $= \left( \frac{4 - 2}{2}, \frac{6 + 2}{2} \right)$ $= (1, 4)$	<p><b>Scale 5C(0, 3, 4, 5)</b></p> <p><i>Low Partial Credit:</i></p> <ul style="list-style-type: none"> <li>• Formula with some substitution</li> </ul> <p><i>High Partial Credit:</i></p> <ul style="list-style-type: none"> <li>• Formula fully substituted</li> <li>• Incorrect substitution into formula and completed correctly</li> </ul> <p><i>Full Credit:</i></p> <ul style="list-style-type: none"> <li>• Correct answer without supporting work</li> </ul>

<p>(b) (ii)</p>	$m_{DE} = \frac{3 - 4}{7 - 1} = \frac{-1}{6}$ $m_{BC} = \frac{0 - 2}{10 + 2} = \frac{-2}{12} = -\frac{1}{6}$	<p><b>Scale 5C(0, 3, 4, 5)</b>  <i>Low Partial Credit:</i></p> <ul style="list-style-type: none"> <li>• Formula with some substitution</li> <li>• States slopes are equal (or similar)</li> </ul> <p><i>High Partial Credit:</i></p> <ul style="list-style-type: none"> <li>• One correct slope</li> <li>• Incorrect substitution into formula and completed correctly</li> </ul>
<p>(c)</p>	<p>A(4, 6) B(-2, 2) C(10, 0)</p> <p>x down 10,      y no change</p> <p style="text-align: right;">↓</p> <p>(-6, 6) (-12, 2) (0, 0)</p> $\text{Area} = \frac{1}{2}  x_1y_2 - x_2y_1 $ $= \frac{1}{2}  (-6)(2) - (-12)(6) $ $= \frac{1}{2}  -12 + 72 $ $= 30 \text{ units}^2$	<p><b>Scale 5D (0, 2, 3, 4, 5)</b>  <i>Low Partial Credit:</i>  Work of merit</p> <ul style="list-style-type: none"> <li>• Translation of any relevant point to (0, 0) indicated</li> <li>• Formula with some substitution</li> </ul> <p><i>Mid Partial Credit:</i></p> <ul style="list-style-type: none"> <li>• Formula fully substituted with 2 from A, B, and C</li> </ul> <p><i>High Partial Credit:</i></p> <ul style="list-style-type: none"> <li>• Formula fully substituted with translated points</li> <li>• Area of triangle found from formula fully substituted with 2 from A, B, and C</li> <li>• Area of triangle found from an incorrect translation</li> </ul>

Q3	Model Solution – 25 Marks	Marking Notes						
(a) (i)	$\frac{1}{\sqrt{1000}} = 0.031622 = 3.2\%$	<p><b>Scale 5C (0, 3, 4, 5)</b></p> <p><i>Low Partial Credit:</i></p> <ul style="list-style-type: none"> <li>Writes <math>\frac{1}{\sqrt{n}}</math></li> <li>Sets up work as <math>\sqrt{1000}</math></li> </ul> <p><i>High Partial Credit:</i></p> <ul style="list-style-type: none"> <li>Formula fully substituted. <math>(\frac{1}{\sqrt{1000}})</math></li> <li>Answer as 0.031622 without work</li> </ul> <p><i>Full Credit:</i></p> <ul style="list-style-type: none"> <li>Correct answer without supporting work</li> </ul> <table border="1" data-bbox="879 757 1423 891"> <tr> <td colspan="2">Special Case</td> </tr> <tr> <td>Without Work</td> <td>Award</td> </tr> <tr> <td>3.1622%</td> <td>F* Full Credit (-1)</td> </tr> </table>	Special Case		Without Work	Award	3.1622%	F* Full Credit (-1)
Special Case								
Without Work	Award							
3.1622%	F* Full Credit (-1)							
(a) (ii)	$\frac{762}{1000} = 0.762 = 76.2\%$ <p>95% confidence interval</p> $= \left[ \hat{p} - \frac{1}{\sqrt{n}}, \hat{p} + \frac{1}{\sqrt{n}} \right]$ $= [76.2\% - 3.2\%, 76.2\% + 3.2\% ]$ $= [73\% , 79.4\%]$ <p>(95% C. I.) <math>73\% \leq \mu \leq 79.4\%</math></p>	<p><b>Scale 5C (0, 3, 4, 5)</b></p> <p><i>Low Partial Credit:</i></p> <p>Work of merit</p> <ul style="list-style-type: none"> <li>Works correctly with margin of error from (a)(i)</li> <li><math>\hat{p} = \frac{762}{1000}</math>.</li> <li><math>\hat{p} \pm \frac{1}{\sqrt{n}}</math>.</li> </ul> <p><i>High Partial Credit:</i></p> <ul style="list-style-type: none"> <li>One boundary formed: (76.2% – 3.2% or 76.2% + 3.2%)</li> <li>Correct answer without supporting work</li> </ul> <p><b>Note:</b></p> <p>Accept use of version of formula from HL (73.6 &lt; <math>\mu</math> &lt; 78.8)</p>						

<p><b>(a)</b> <b>(iii)</b></p>	$H_0 = 80\%$ $H_1 \neq 80\%$ <p>80% is not within the 95% C.I. above ( <math>73\% \leq \mu \leq 79.2\%</math> )</p> <p>Therefore there is sufficient evidence to reject <math>H_0</math>, and conclude that the percentage of people who believe that it is safe to give their credit card details online is not 80% .</p>	<p><b>Scale 5C (0, 3, 4, 5)</b> <i>Low Partial Credit:</i> Work of merit</p> <ul style="list-style-type: none"> <li>• Null hypothesis stated</li> <li>• 95% C. I. written</li> </ul> <p><i>High Partial Credit:</i></p> <ul style="list-style-type: none"> <li>• Conclusion OK but reason incorrect or omitted</li> <li>• Reason OK but conclusion incorrect, omitted or not in context</li> </ul>
<p><b>(b)</b> <b>(i)</b></p>	$A = 390 \quad B = 570$	<p><b>Scale 5B (0, 2, 5)</b> <i>Partial Credit:</i> Work of merit</p> <ul style="list-style-type: none"> <li>• One boundary written [ 480 – 90]</li> </ul>
<p><b>(b)</b> <b>(ii)</b></p>	$\bar{x} \pm \sigma = 68\%$ $68\% \text{ of } 6500 = 4420$	<p><b>Scale 5C (0, 3, 4, 5)</b> <i>Low Partial Credit:</i> Work of merit</p> <ul style="list-style-type: none"> <li>• 68% identified</li> <li>• Knowledge of Empirical Rule displayed</li> </ul> <p><i>High Partial Credit:</i> Significant work</p> <ul style="list-style-type: none"> <li>• 68% of incorrect value found correctly</li> <li>• Correct use of incorrect percentage ( <math>95\% = 6175, \quad 99.7\% = 6480.5</math> )</li> </ul> <p><i>Full Credit:</i></p> <ul style="list-style-type: none"> <li>• Correct answer without supporting work</li> </ul>

Q4	Model Solution – 25 Marks	Marking Notes
(a) (i)	Centre $(1, -4)$  Radius 5	<b>Scale 10B (0, 5, 10)</b> <i>Partial Credit:</i> Work of merit <ul style="list-style-type: none"> <li>• Centre or radius correct</li> </ul> <i>Full Credit:</i> <ul style="list-style-type: none"> <li>• Correct answer without supporting work</li> </ul>
(a) (ii)	$(1 - 1)^2 + (k + 4)^2 = 25$ $(k + 4)^2 = 25$ $k^2 + 8k - 9 = 0$ $(k - 1)(k + 9) = 0$ $k = 1 \quad k = -9$ Or $(k + 4)^2 = 25$ $k + 4 = \pm 5$ $k = 1 \quad k = -9$	<b>Scale 5D (0, 2, 3, 4, 5)</b> <i>Low Partial Credit:</i> Work of merit <ul style="list-style-type: none"> <li>• Formula with some substitution</li> </ul> <i>Mid Partial Credit:</i> <ul style="list-style-type: none"> <li>• Formula fully substituted  <math>(1 - 1)^2 + (k + 4)^2 = 25</math></li> </ul> <i>High Partial Credit:</i> Significant work <ul style="list-style-type: none"> <li>• <math>k^2 + 8k - 9 = 0</math></li> <li>• <math>k + 4 = \pm 5</math></li> <li>• Substituting <math>(k, 1)</math> into formula and completed correctly</li> </ul>

<p><b>(b)</b></p>	$m_{Radius} = -\frac{2}{3}$ <p><math>\Rightarrow</math> Perpendicular slope <math>= \frac{3}{2}</math></p> $y + 2 = \frac{3}{2}(x - 3)$ $2y + 4 = 3x - 9$ $3x - 2y - 13 = 0$ <p>or</p> $(x - h)(x_1 - h) + (y - k)(y_1 - k) = r^2$ $(x - 0)(3 - 0) + (y - 0)(-2 - 0) = 13$ $3x - 2y - 13 = 0$	<p><b>Scale 10D (0, 3, 5, 8, 10)</b></p> <p><i>Low Partial Credit:</i></p> <p>Work of merit</p> <ul style="list-style-type: none"> <li>• Formula with some substitution</li> </ul> <p><i>Mid Partial Credit:</i></p> <ul style="list-style-type: none"> <li>• <math>m_R</math> and/or <math>m_T</math> found</li> <li>• HL Formula with any <u>2</u> of the <u>3</u> elements substituted correctly</li> </ul> <p><i>High Partial Credit:</i></p> <ul style="list-style-type: none"> <li>• Eq. of line formula fully substituted</li> <li>• One incorrect substitution followed by correct solution</li> </ul> <p><b>Note:</b> Accept <math>(-3x + 2y + 13 = 0)</math></p>
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Q5	Model Solution – 25 Marks	Marking Notes
(a)	$\sin 55 = \frac{100}{h}$ $h = \frac{100}{\sin 55}$ $h = 122.077$ $h = 122$	<p><b>Scale 10C (0, 4, 8, 10)</b></p> <p><i>Low Partial Credit:</i> Work of merit</p> <ul style="list-style-type: none"> <li>• Formula with some substitution</li> </ul> <p><i>High Partial Credit:</i></p> <ul style="list-style-type: none"> <li>• Formula fully substituted</li> </ul> <p><i>Full Credit:</i></p> <ul style="list-style-type: none"> <li>• Correct answer without supporting work</li> </ul>
(b)	$\sin \theta = \frac{100}{200} = \frac{1}{2}$ $\Rightarrow \theta = \sin^{-1}\left(\frac{1}{2}\right) = 30^\circ$	<p><b>Scale 5C (0, 3, 4, 5)</b></p> <p><i>Low Partial Credit:</i> Work of merit</p> <ul style="list-style-type: none"> <li>• Formula with some substitution</li> </ul> <p><i>High Partial Credit:</i></p> <ul style="list-style-type: none"> <li>• Formula fully substituted</li> </ul> <p><i>Full Credit:</i></p> <ul style="list-style-type: none"> <li>• Correct answer without supporting work</li> </ul>



<p><b>(c)</b></p>	$ \angle X  = 180 - (45 + 40) = 95^\circ$ $d^2 = (141.4)^2 + (155.6)^2 - 2(141.4)(155.6) \cos 95^\circ$ $d = 219.181$ $d = 219$ <p style="text-align: center;">or</p> $\frac{d}{\sin 95} = \frac{155.6}{\sin 45}$ $d = \frac{155.6 \times (\sin 95)}{\sin 45}$ $d = 219.214$ $d = 219$	<p><b>Scale 10C (0, 4, 8, 10)</b></p> <p><i>Low Partial Credit:</i> Work of merit</p> <ul style="list-style-type: none"> <li>• Formula with some substitution</li> </ul> <p><i>High Partial Credit:</i></p> <ul style="list-style-type: none"> <li>• Formula fully substituted</li> <li>• One incorrect substitution followed by correct solution</li> </ul>
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Q6	Model Solution – 25 Marks	Marking Notes
(a)	$(3x + y) + (x + y) + 80 = 180$ $\Rightarrow 4x + 2y = 100$ $\Rightarrow 2x + y = 50$ <p>Simultaneous Equations:</p> $3x + y = 60$ $\underline{-2x - y = -50}$ $x = 10$ $\Rightarrow y = 30$ <p>Giving <math>x = 10</math> and <math>y = 30</math></p>	<p><b>Scale 20D (0, 5, 10, 15, 20)</b></p> <p><i>Low Partial Credit:</i> Work of merit</p> <ul style="list-style-type: none"> <li>• Knowledge of sum of angles in a triangle = <math>180^\circ</math> shown</li> <li>• Knowledge of vertically opposite angles being equal shown</li> </ul> <p><i>Mid Partial Credit:</i></p> <ul style="list-style-type: none"> <li>• One relevant equation found</li> </ul> <p><i>High Partial Credit:</i></p> <ul style="list-style-type: none"> <li>• Two relevant equations found</li> <li>• Finds one solution</li> <li>• Correct answer without supporting work</li> </ul>
(b)	$\frac{x}{5} = \frac{18}{12}$ $12x = 90$ $x = 7.5 \text{ cm}$	<p><b>Scale 5C (0, 3, 4, 5)</b></p> <p><i>Low Partial Credit:</i> Work of merit</p> <ul style="list-style-type: none"> <li>• Any relevant work with ratio of lengths</li> </ul> <p><i>High Partial Credit:</i></p> <ul style="list-style-type: none"> <li>• Correct ratio equality</li> <li>• Incorrect ratio equality and finished correctly</li> </ul>

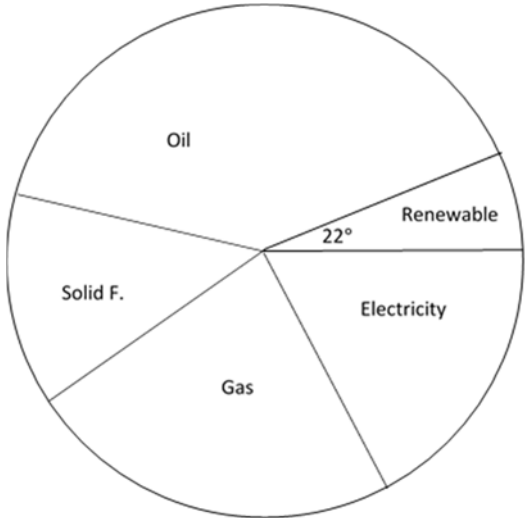
## Section B

Q7	Model Solution – 55 Marks	Marking Notes
(a) (i)	$60^\circ + 45^\circ = 105^\circ$ <p style="text-align: center;">or <math>180^\circ - 30^\circ - 45^\circ = 105^\circ</math></p> <p style="text-align: center;">or <math>180^\circ - (30^\circ + 45^\circ) = 105^\circ</math></p>	<p><b>Scale 10B (0, 5, 10)</b></p> <p><i>Partial Credit:</i></p> <p>Work of merit</p> <ul style="list-style-type: none"> <li>• Knowledge of sum of angles in a triangle = <math>180^\circ</math> shown</li> </ul>
(a) (ii)	$\frac{y}{\sin 30} = \frac{100}{\sin 105}$ $y = \frac{100 \sin 30}{\sin 105}$ $y = 51.7638$ $y = 51.8 \text{ m}$	<p><b>Scale 10C (0, 4, 8, 10)</b></p> <p><i>Low Partial Credit:</i></p> <p>Work of merit</p> <ul style="list-style-type: none"> <li>• Formula with some substitution</li> </ul> <p><i>High Partial Credit:</i></p> <ul style="list-style-type: none"> <li>• Formula fully substituted</li> </ul>
(a) (iii)	$\sin 45 = \frac{h}{51.8}$ $h = 36.62813$ $h = 36.6 \text{ m}$ $\sin 30 = \frac{36.6}{x}$ $x = \frac{36.6}{\sin 30}$ $x = 73.2 \text{ m}$	<p><b>Scale 10D (0, 3, 5, 8, 10)</b></p> <p><i>Low Partial Credit:</i></p> <p>Work of merit</p> <ul style="list-style-type: none"> <li>• Formula with some substitution</li> </ul> <p><i>Mid Partial Credit:</i></p> <ul style="list-style-type: none"> <li>• <math>h</math> or <math>x</math> found</li> </ul> <p><i>High Partial Credit:</i></p> <ul style="list-style-type: none"> <li>• Both formula fully substituted</li> <li>• Incorrect substitution followed by correct solution</li> </ul>

<b>(b)</b>	$1.23[25(73.2 + 51.8) + 580(36.6)]$ $= 1.23(24353)$ $= \text{€}29\,954.19$	<p><b>Scale 10C (0, 4, 8, 10)</b>  <i>Low Partial Credit:</i>  Work of merit</p> <ul style="list-style-type: none"> <li>• Cost of any element indicated</li> </ul> <p><i>High Partial Credit:</i></p> <ul style="list-style-type: none"> <li>• Each element excluding VAT formulated</li> </ul>
<b>(c)</b> <b>(i)</b>	$\text{Area} = 6 \left[ \frac{1}{2}(8)(8) \sin 60 \right]$ $= 6[27.71281292]$ $= 166.28 \text{ (km}^2\text{)}$	<p><b>Scale 10C (0, 4, 8, 10)</b>  <i>Low Partial Credit:</i>  Work of merit</p> <ul style="list-style-type: none"> <li>• Formula with some substitution</li> </ul> <p><i>High Partial Credit:</i></p> <ul style="list-style-type: none"> <li>• Formula fully substituted</li> <li>• One incorrect substitution followed by correct solution</li> </ul>
<b>(c)</b> <b>(ii)</b>	$\text{Area} = \frac{1}{6}[\pi(8^2) - 166 \cdot 28]$ $= \frac{1}{6}[34.78192983]$ $= 5.7969$ $= 5.8 \text{ (km}^2\text{)}$	<p><b>Scale 5C (0, 3, 4, 5)</b>  <i>Low Partial Credit:</i>  Work of merit</p> <ul style="list-style-type: none"> <li>• Formula with some substitution</li> </ul> <p><i>High Partial Credit:</i></p> <ul style="list-style-type: none"> <li>• Shaded area fully substituted</li> </ul>

Q8	Model Solution – 55 Marks	Marking Notes
(a) (i)	$\frac{1833 \times 100}{2779} - \frac{1344 \times 100}{2547}$ $= 65.95\% - 52.77\%$ $= 13.18\%$ $= 13.2\%$	<p><b>Scale 5C (0, 3, 4, 5)</b></p> <p><i>Low Partial Credit:</i> Work of merit</p> <ul style="list-style-type: none"> <li>Any correct element <math>\frac{1833}{2779}</math> or <math>\frac{1344}{2547}</math></li> </ul> <p><i>High Partial Credit:</i> Significant work.</p> <ul style="list-style-type: none"> <li>Both <math>\frac{1833}{2779}</math> and <math>\frac{1344}{2547}</math> shown</li> </ul>
(a) (ii)	$(2779 + 3100 + 3175 + 3104 + 2825 + 2580 + 2547) \div 7$ $= \frac{20110}{7}$ $= 2872.857$ $= 2872.9 \text{ kt}$	<p><b>Scale 10C (0, 4, 8, 10)</b></p> <p><i>Low Partial Credit:</i></p> <ul style="list-style-type: none"> <li>Formula with some substitution</li> </ul> <p><i>High Partial Credit:</i></p> <ul style="list-style-type: none"> <li>Formula fully substituted</li> <li>Calculates the mean of the waste sent to landfill (Ans = 1761.7)</li> </ul> <p><i>Full Credit:</i></p> <ul style="list-style-type: none"> <li>Correct answer without supporting work</li> </ul>
(a) (iii)	$\frac{1724 + 1496 + 1344 + x}{4} = 1398$ $\frac{4564 + x}{4} = 1398$ $x = 1028 \text{ kt}$	<p><b>Scale 5C (0, 3, 4, 5)</b></p> <p><i>Low Partial Credit:</i> Work of merit</p> <ul style="list-style-type: none"> <li>Effort at adding 3 relevant landfill waste data</li> <li>Indicates the total value as: <math>1398 \times 4</math></li> </ul> <p><i>High Partial Credit:</i> Significant work</p> <ul style="list-style-type: none"> <li><math>1398 = \frac{\sum_1^4 \text{Landfill data}}{4}</math></li> </ul>

<p><b>(b)</b> <b>(i)</b></p>	$31 + 11 + 13 + 12 + 13 = 80$ $100 - 80 = 20\%$	<p><b>Scale 5B (0, 2, 5)</b>  <i>Low Partial Credit:</i>  Work of merit</p> <ul style="list-style-type: none"> <li>• Addition or indication of addition of some of Denmark data</li> </ul> <p><i>Full Credit:</i></p> <ul style="list-style-type: none"> <li>• Correct answer without supporting work</li> </ul>
<p><b>(b)</b> <b>(ii)</b></p>	<p>Cyprus, Luxemburg, Malta, Netherlands.</p>	<p><b>Scale 5C (0, 3, 4, 5)</b>  <i>Low Partial Credit:</i>  Work of merit</p> <ul style="list-style-type: none"> <li>• Any correctly identified country</li> </ul> <p><i>High Partial Credit:</i>  Significant work</p> <ul style="list-style-type: none"> <li>• Three correct only</li> <li>• Four correct but with additional incorrect data</li> </ul>
<p><b>(b)</b> <b>(iii)</b></p>	<p>Cyprus or Malta</p>	<p><b>Scale 5A (0, 5)</b></p>

<p>(b) (iv)</p>	$\frac{42}{100} \times 360 = 151.2 = 151^\circ$ $\frac{13}{100} \times 360 = 46.8 = 47^\circ$ $\frac{24}{100} \times 360 = 86.4 = 86^\circ$ $\frac{15}{100} \times 360 = 54^\circ$ $\left[ \frac{6}{100} \times 360 = 21.6 = 22^\circ \right]$	<p><b>Scale 10D (0, 3, 5, 8, 10)</b>  <i>Low Partial Credit:</i>  Work of merit <ul style="list-style-type: none"> <li>• One new angle correctly formulated</li> </ul> <i>Mid Partial Credit:</i> <ul style="list-style-type: none"> <li>• Two angles found</li> </ul> <i>High Partial Credit:</i> <ul style="list-style-type: none"> <li>• Three angles found</li> <li>• Completes using [6% = 22°]</li> </ul> <i>Full Credit:</i> <ul style="list-style-type: none"> <li>• Correct answer without supporting work</li> </ul> </p>
<p>(b) (v)</p>	<p>Pie chart</p> 	<p><b>Scale 10D (0, 3, 5, 8, 10)</b>  <i>Low Partial Credit:</i>  Work of merit <ul style="list-style-type: none"> <li>• One correct/ relevant new sector added to the pie chart</li> </ul> <i>Mid Partial Credit:</i> <ul style="list-style-type: none"> <li>• Two correct/ relevant new sectors added to the pie chart</li> </ul> <i>High Partial Credit:</i> <ul style="list-style-type: none"> <li>• Labels omitted</li> </ul> </p>

Q9	Model Solution – 40 Marks	Marking Notes
(a) (i)	$10 + \text{Diameter} = 16$ $\text{Diameter} = 6$ $\text{Radius} = 3 \text{ (cm)}$	<p><b>Scale 10C (0, 4, 8, 10)</b></p> <p><i>Low Partial Credit:</i> Work of merit</p> <ul style="list-style-type: none"> <li>Vertical diameter indicated on diagram</li> </ul> <p><i>High Partial Credit:</i></p> <ul style="list-style-type: none"> <li>Finds Diameter = 6</li> </ul>
(a) (ii)	$y = 2\pi r$ $= 2\pi(3)$ $= 6\pi$ $= 18.8495 \dots$ $= 19 \text{ (cm)}$	<p><b>Scale 5B (0, 2, 5)</b></p> <p><i>Partial Credit</i> Work of merit</p> <ul style="list-style-type: none"> <li>Formula with some substitution</li> </ul> <p><i>Full Credit:</i></p> <ul style="list-style-type: none"> <li>Correct answer without supporting work.</li> </ul>
(a) (iii)	<p>Area of sheet = <math>6\pi \times 16 = 96\pi</math></p> <p>C.S.A = <math>6\pi \times 10 = 60\pi</math></p> <p>Area of circles = <math>2\pi(3)^2 = 18\pi</math></p> <p>Waste = <math>96\pi - (60\pi + 18\pi)</math></p> $= 96\pi - 78\pi$ $= 18\pi$ $= 56.548 \dots$ $= 57 \text{ (cm}^2\text{)}$	<p><b>Scale 5C (0, 3, 4, 5)</b></p> <p><i>Low Partial Credit:</i></p> <ul style="list-style-type: none"> <li>Any area formula with some substitution</li> </ul> <p><i>High Partial Credit:</i></p> <ul style="list-style-type: none"> <li><b>Two</b> of the three required areas calculated correctly.</li> <li>Uses only one circle and finishes consistently</li> </ul>



<p><b>(b)</b> <b>(i)</b></p>	$\text{Volume} = \frac{4}{3}\pi(1.5)^3$ $= \frac{4}{3}\pi\left(\frac{27}{8}\right)$ $= \frac{9\pi}{2} \text{ cm}^3$	<p><b>Scale 10B (0, 5, 10)</b> <i>Partial Credit:</i></p> <ul style="list-style-type: none"> <li>• Formula with some substitution</li> <li>• Answer not in terms of <math>\pi</math> (14.137 cm<sup>3</sup>)</li> </ul> <p><i>Full Credit:</i></p> <ul style="list-style-type: none"> <li>• Correct answer without supporting work</li> </ul>
<p><b>(b)</b> <b>(ii)</b></p>	<p>Volume<sub>Risen Water</sub> = Volume<sub>Added ice</sub></p> $\pi(3.5)^2 h = 3\left(\frac{9\pi}{2}\right)$ $h = \frac{27}{2(3.5)^2}$ $= 1.102$ $= 1.1 \text{ cm}$	<p><b>Scale 10D (0, 3, 5, 8, 10)</b> <i>Low Partial Credit:</i> Work of merit</p> <ul style="list-style-type: none"> <li>• Formula with some substitution</li> </ul> <p><i>Mid Partial Credit:</i></p> <ul style="list-style-type: none"> <li>• Both volume formulae fully substituted correctly</li> </ul> <p><i>High Partial Credit:</i></p> <ul style="list-style-type: none"> <li>• Volume equation set up correctly and correctly substituted</li> <li>• Equation written with <math>h</math> as subject</li> </ul>

## 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.  $198 \text{ marc} \times 5\% = 9.9 \Rightarrow$  bónas = 9 marc.

Má ghnóthaíonn an t-iarrthóir níos mó ná 225 marc, ríomhtar an bónas de réir na foirmle  $[300 - \text{bunmharc}] \times 15\%$ , 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



