



Coimisiún na Scrúduithe Stáit
State Examinations Commission

Junior Certificate 2017

Marking Scheme

Mathematics

Higher Level

Note to teachers and students on the use of published marking schemes

Marking schemes published by the State Examinations Commission are not intended to be standalone documents. They are an essential resource for examiners who receive training in the correct interpretation and application of the scheme. This training involves, among other things, marking samples of student work and discussing the marks awarded, so as to clarify the correct application of the scheme. The work of examiners is subsequently monitored by Advising Examiners to ensure consistent and accurate application of the marking scheme. This process is overseen by the Chief Examiner, usually assisted by a Chief Advising Examiner. The Chief Examiner is the final authority regarding whether or not the marking scheme has been correctly applied to any piece of candidate work.

Marking schemes are working documents. While a draft marking scheme is prepared in advance of the examination, the scheme is not finalised until examiners have applied it to candidates' work and the feedback from all examiners has been collated and considered in light of the full range of responses of candidates, the overall level of difficulty of the examination and the need to maintain consistency in standards from year to year. This published document contains the finalised scheme, as it was applied to all candidates' work.

In the case of marking schemes that include model solutions or answers, it should be noted that these are not intended to be exhaustive. Variations and alternatives may also be acceptable. Examiners must consider all answers on their merits, and will have consulted with their Advising Examiners when in doubt.

Future Marking Schemes

Assumptions about future marking schemes on the basis of past schemes should be avoided. While the underlying assessment principles remain the same, the details of the marking of a particular type of question may change in the context of the contribution of that question to the overall examination in a given year. The Chief Examiner in any given year has the responsibility to determine how best to ensure the fair and accurate assessment of candidates' work and to ensure consistency in the standard of the assessment from year to year. Accordingly, aspects of the structure, detail and application of the marking scheme for a particular examination are subject to change from one year to the next without notice.

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Paper 1

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 on this examination paper are summarised in this table:

Scale label	B	C	D
No of categories	3	4	5
5-mark scale	0, 2, 5	0, 2, 3, 5	0, 2, 3, 4, 5
10-mark scale	0, 5, 10	0, 5, 7, 10	0, 4, 6, 8, 10
15-mark scale		0, 8, 11, 15	0, 7, 9, 12, 15

A general descriptor of each point on each scale is given below. More specific directions in relation to interpreting the scales in the context of each question are given in the scheme, where necessary.

Marking scales – level descriptors

A-scales (two categories)

- incorrect response (no credit)
- correct response (full credit)

B-scales (three categories)

- response of no substantial merit (no credit)
- partially correct response (partial credit)
- correct response (full credit)

C-scales (four categories)

- response of no substantial merit (no credit)
- response with some merit (low partial credit)
- almost correct response (high partial credit)
- correct response (full credit)

D-scales (five categories)

- response of no substantial merit (no credit)
- response with some merit (low partial credit)
- response about half-right (mid partial credit)
- almost correct response (high partial credit)
- correct response (full credit)

In certain cases, typically involving incorrect rounding, omission of units, a misreading that does not oversimplify the work, or an arithmetical error that does not oversimplify the work, a mark that is one mark below the full-credit mark may be awarded. This level of credit is referred to as *Full Credit –1*, and these types of errors are identified with an asterisk (*). Thus, for example, in Scale 10C, *Full Credit –1* of 9 marks may be awarded.

No marks may be awarded other than those on the appropriate scale, and *Full Credit –1*.

In general, accept a candidate’s work in one part of a question for use in subsequent parts of the question, unless this oversimplifies the work involved.

Summary of mark allocations and scales to be applied

Question 1 (25)

- (a) 15D
- (b) 10C

Question 2 (20)

- (a) 15D
- (b) 5C

Question 3 (15)

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

Question 4 (15)

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

Question 5 (25)

- (a), (b) 15C
- (c) 10D

Question 6 (35)

- (a) 15C
- (b) 5B
- (c) 15D

Question 7 (5)

- (a), (b) 5D

Question 8 (30)

- (a), (b) 15D
- (c) 5D
- (d) 10D

Question 9 (25)

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

Question 10 (10)

- (a) 5B
- (b), (c) 5D

Question 11 (20)

- (a) 10C
- (b) 10C

Question 12 (35)

- (a) 5C
- (b) 5C
- (c) 10B
- (d) 5D
- (e) 10D

Question 13 (15)

15D

Question 14 (20)

- (a), (c) 10D
- (b) 5B
- (d) 5B

Question 15 (5)

5B

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.

Q1	Model Solution – 25 Marks	Marking Notes
(a)	<p>(i) $\text{BMI} = \frac{77.5}{(1.63)^2}$ $= 29.169\dots$ $= 29.2 \text{ [1 D.P.]}$</p> <p>(ii) $w = \text{BMI} \times h^2$ $= 24 \times (1.63)^2$ $= 63.76\dots$ $= 63.8 \text{ [kg] [1 D.P.]}$</p>	<p>Scale 15D (0, 7, 9, 12, 15)</p> <p>Accept correct answers without work. Accept correct answer without units in (ii). <i>Low Partial Credit</i></p> <ul style="list-style-type: none"> • Work of merit in one part, for example: some correct substitution into either (i) or (ii). <p><i>Mid Partial Credit</i></p> <ul style="list-style-type: none"> • (i) correct. • Work of merit in both (i) and (ii). <p><i>High Partial Credit</i></p> <ul style="list-style-type: none"> • Swaps 77.5 and 1.63 but finishes correctly. • (ii) correct. • (i) correct and work of merit in (ii). <p><i>Full Credit –1</i></p> <ul style="list-style-type: none"> • Apply a * to incorrect rounding the first time it occurs.
(b)	<p><i>Answer:</i> less than Jo's</p> <p><i>Justification – accept:</i> Alex is dividing the same top line as Jo by a bigger number.</p> <p style="text-align: center;">OR</p> $\frac{w}{(h + 0.10)^2} < \frac{w}{h^2}$ <p style="text-align: center;"><i>or any valid justification</i></p>	<p>Scale 10C (0, 5, 7, 10)</p> <p><i>Low Partial Credit</i></p> <ul style="list-style-type: none"> • Correct answer. • Work of merit in justification, for example: attempts to substitute in particular values to check. <p><i>High Partial Credit</i></p> <ul style="list-style-type: none"> • Correct answer with work of merit in justification. • Justification fully correct. <p><i>Full Credit –1</i></p> <ul style="list-style-type: none"> • Apply a * if answer given as "Jo's BMI is greater than Alex's"

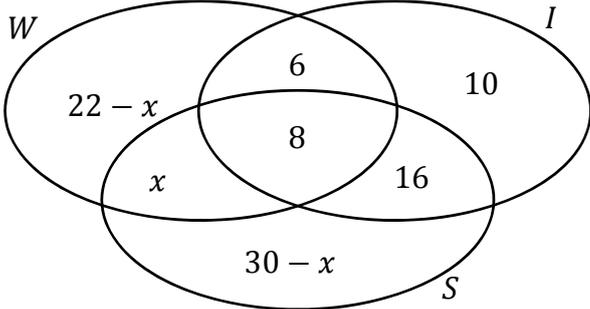
Q2	Model Solution – 20 Marks	Marking Notes
(a)	<p>Profit = $49 - 25 = €24$</p> <p>(i) Mark up = $\frac{24}{25} \times 100 = 96$ [%]</p> <p>(ii) Margin = $\frac{24}{49} \times 100$ = $48.9\dots$ = 49 [%] [nearest %]</p>	<p>Scale 15D (0, 7, 9, 12, 15)</p> <p>Accept correct answers without work.</p> <p>Accept correct answer without % sign (96 and 49).</p> <p><i>Low Partial Credit</i></p> <ul style="list-style-type: none"> • Work of merit in either (i) or (ii), for example: $49 - 25$; or something $\times 100$. <p><i>Mid Partial Credit</i></p> <ul style="list-style-type: none"> • Work of merit in both (i) and (ii). • Either (i) or (ii) correct. <p><i>High Partial Credit</i></p> <ul style="list-style-type: none"> • One part correct and work of merit in the other. • Both correct as decimals rather than percentages (0.96 and 0.49). • Calculates Margin in (i) and Mark up in (ii). <p><i>Full Credit –1</i></p> <ul style="list-style-type: none"> • Apply a * for incorrect rounding in (ii)
(b)	<p>Markup = $50\% = 0.5 = \frac{\text{Profit}}{\text{Cost}}$</p> <p>$\Rightarrow P = 0.5C$</p> <p>$\Rightarrow$ Selling Price (S) = $C + P = 1.5C$</p> <p>\Rightarrow Margin = $\frac{P}{S} = \frac{0.5C}{1.5C} = \frac{1}{3}$ = 33 [%] [nearest %]</p> <p>OR</p> <p>$\frac{\frac{x}{2}}{x + \frac{x}{2}} \times 100 = \frac{1}{3} \times 100$ = $33\frac{1}{3}$ = 33 [%] [nearest %]</p>	<p>Scale 5C (0, 2, 3, 5)</p> <p>Accept correct answer without work.</p> <p>Accept correct answer without % sign (33).</p> <p>Accept justification using particular values.</p> <p><i>Low Partial Credit</i></p> <ul style="list-style-type: none"> • Makes relevant use of 50%, for example: 150%, or 1.5, or $C = 2P$. <p><i>High Partial Credit</i></p> <ul style="list-style-type: none"> • $\frac{1}{3}$, or 0.33, or $0.\dot{3}$ <p><i>Full Credit –1</i></p> <ul style="list-style-type: none"> • Apply a * for incorrect rounding, if not already applied in (a)(ii)

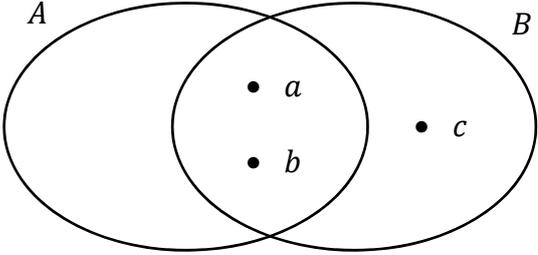
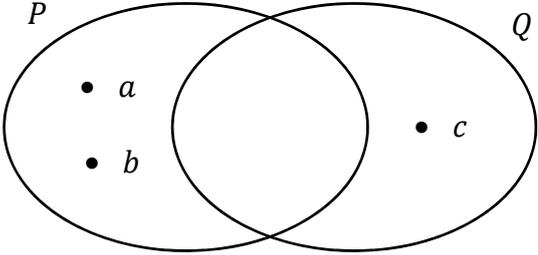
Q3	Model Solution – 15 Marks	Marking Notes
(a)	$868 \text{ million} = 868 \times 10^6$ $= 8.68 \times 10^2 \times 10^6$ $= 8.68 \times 10^8$	<p>Scale 5C (0, 2, 3, 5)</p> <p>Accept correct answer without work.</p> <p><i>Low Partial Credit</i></p> <ul style="list-style-type: none"> Some work of merit, for example: 1 000 000, or 8.68. <p><i>High Partial Credit</i></p> <ul style="list-style-type: none"> Correct value but not in correct form, for example: 868 000 000, or 868×10^6 8.68×10^2 or 8.68×10^6
(b), (c)	<p>(b) 1.3 secs \rightarrow 380 000 km</p> <p>1 sec $\rightarrow \frac{380\,000}{1.3}$ km</p> <p>1 min $\rightarrow 60 \times \frac{380\,000}{1.3}$ km</p> <p>$= 1.75 \times 10^7$ [km/min] [2 D.P.]</p> <p>(c) $\frac{8.68 \times 10^8}{1.75 \times 10^7} = 49.6$ [minutes]</p>	<p>Scale 10D (0, 4, 6, 8, 10)</p> <p>Accept correct answers without units.</p> <p><i>Low Partial Credit</i></p> <ul style="list-style-type: none"> Some relevant calculation in either (b) or (c). <p><i>Mid Partial Credit</i></p> <ul style="list-style-type: none"> (b) or (c) correct Some relevant calculation in both (b) and (c). <p><i>High Partial Credit</i></p> <ul style="list-style-type: none"> One part correct and some relevant calculation in the other Correct answers with no supporting work in (c) <p><i>Full Credit –1</i></p> <ul style="list-style-type: none"> Apply a * for incorrect rounding in (b). Apply a * in (c) if candidate uses values in (c) other than their answer from (b).

Q4	Model Solution – 15 Marks	Marking Notes
(a), (b)(i)	<p>(a) $£0.7241 = €1.00$</p> $£1 = € \frac{1}{0.7241}$ $£380 = € \frac{380}{0.7241}$ $= €524.789 \dots$ $= [€]524.79 [2 \text{ D.P.}]$ <p>(b)(i) $3 + 7 = 10$</p> $\Rightarrow \text{Juice in Fruitex} = \frac{3}{10} \times 20$ $= 6 \text{ [litres]}$	<p>Scale 10D (0, 4, 6, 8, 10)</p> <p>Accept correct answers without work. Accept correct answers without units.</p> <p><i>Low Partial Credit</i></p> <ul style="list-style-type: none"> Some relevant calculation in either (a) or (b). <p><i>Mid Partial Credit</i></p> <ul style="list-style-type: none"> Either (a) or (b) correct. Some relevant calculation in both (a) and (b). <p><i>High Partial Credit</i></p> <ul style="list-style-type: none"> Either (a) or (b) correct, and some relevant calculation in the other part. <p><i>Full Credit –1</i></p> <ul style="list-style-type: none"> Apply a * for incorrect rounding in (a). Apply a * in (b)(i) if the amount of water is found (14 litres), or if 6 and 14 are found but answer is not identified.
(b)(ii)	$7 + 8 = 15$ $\Rightarrow \text{Juice in mix} = \frac{7}{15} \times 60$ $= 28 \text{ litres}$ $\Rightarrow \text{Juice in Juicy} = 28 - 6 = 22 \text{ litres}$ $\Rightarrow \text{Water in Juicy} = 40 - 22 = 18 \text{ litres}$ $\Rightarrow \text{Ratio of juice to water in Juicy}$ $= 22:18$ $= 11:9$ <p style="text-align: center;">OR</p> $7:8 = 15 \text{ [Ratio in mixture]}$ $\Rightarrow 28:32 = 60 \text{ [Litres in mixture]}$ $- \underline{6:14} \text{ [Litres in Fruitex]}$ $= 22:18 \text{ [Ratio in Juicy]}$ $= 11:9. \text{ [Ratio in Juicy]}$	<p>Scale 5C (0, 2, 3, 5)</p> <p><i>Low Partial Credit</i></p> <ul style="list-style-type: none"> Work of merit using the correct ratio, for example: 7 + 8 <p><i>High Partial Credit</i></p> <ul style="list-style-type: none"> Finds 22 litres or 18 litres Correct answer without work <p><i>Full Credit –1</i></p> <ul style="list-style-type: none"> Apply a * for ratio not in simplest form.

Q5	Model Solution – 25 Marks	Marking Notes
(a), (b)	(a)(i) $20 + (5 \times 12) = [\text{€}] 80$ (a)(ii) $[\text{€}] 20 + 12n$ (b) $[\text{€}] 15 + 6n$	<p>Scale 15C (0, 8, 11, 15)</p> <p>Accept correct answers without work. Accept correct answers without units.</p> <p><i>Low Partial Credit</i></p> <ul style="list-style-type: none"> • Work of merit in one of the three parts, for example: in (a)(i): one relevant calculation; in (a)(ii): $7 + 12n$ (coefficient of n correct), or $20 + 9n$ (constant correct) <p><i>High Partial Credit</i></p> <ul style="list-style-type: none"> • Work of merit in (a)(ii) and (b) • (a)(ii) or (b) correct

Q5	Model Solution – 25 Marks	Marking Notes
(c)	<p>Interpretation 1, Method 1:</p> $\frac{1}{4}(12n + 20) + \frac{2}{3}(6n + 15) = 200$ $3n + 5 + 4n + 10 = 200$ $7n + 15 = 200$ $7n = 185$ $n = \frac{185}{7} = 26.4 \dots$ <p>i.e. 27 [weeks]</p> <p style="text-align: center;">OR</p> <p>Interpretation 1, Method 2:</p> <p>Pete: Starts with 5, plus 3 each week Maeve: Starts with 10, plus 4 each week In total: They start with 15, plus 7 each week</p> $\frac{200-15}{7} = 26.4 \dots$ <p>i.e. 27 [weeks]</p> <p style="text-align: center;">OR</p> <p>Interpretation 2, Method 1:</p> <p>Pete: $\frac{1}{4}(12n + 20) = 200$</p> $12n + 20 = 800$ $n = 65 \text{ [weeks]}$ <p>Maeve: $\frac{2}{3}(6n + 15) = 200$</p> $12n + 30 = 600$ $n = 47.5$ <p>i.e. 48 [weeks]</p> <p style="text-align: center;">OR</p> <p>Interpretation 2, Method 2:</p> <p>Pete: Starts with 5, plus 3 each week</p> $\frac{200-5}{3} = 65 \text{ [weeks]}$ <p>Maeve: Starts with 10, plus 4 each week</p> $\frac{200-10}{4} = 47.5$ <p>i.e. 48 [weeks]</p> <p style="text-align: center;">OR</p> <p>Either Interpretation, Method 3: Solution via trial and improvement.</p>	<p>Scale 10D (0, 4, 6, 8, 10)</p> <p>Accept correct answer without units.</p> <p>Accept solution using interpretation 1 or interpretation 2.</p> <p>If using trial and improvement, must have supporting work to show that the given answer is the smallest number of weeks that is sufficient.</p> <p>Consider the solution as having 4 steps:</p> <p>Step 1: Sets up correct expression for either Pete or Maeve.</p> <p>Step 2: Sets up correct expressions for Pete and Maeve; OR Solves correctly for either Pete or Maeve.</p> <p>Step 3: Distributes the fractions correctly in equation(s).</p> <p>Step 4: Solves equation(s).</p> <p><i>Low Partial Credit</i></p> <ul style="list-style-type: none"> • 1 step correct. • $12n + 20 + 6n + 15 = 200$ solved correctly. • $12n + 20 = 200$ and $6n + 15 = 200$ both solved correctly. <p><i>Mid Partial Credit</i></p> <ul style="list-style-type: none"> • 2 steps correct. <p><i>High Partial Credit</i></p> <ul style="list-style-type: none"> • 3 steps correct. • Correct answer, but without supporting work to show that it is the smallest number of weeks that is sufficient. <p><i>Full Credit –1</i></p> <ul style="list-style-type: none"> • Apply * for incorrect / no rounding. • Apply * if $\frac{1}{4}$ and $\frac{2}{3}$ swapped.

Q6	Model Solution – 35 Marks	Marking Notes
(a)		<p>Scale 15C (0, 8, 11, 15)</p> <p>Accept correct answer without work.</p> <p><i>Low Partial Credit</i></p> <ul style="list-style-type: none"> • 2 regions correct <p><i>High Partial Credit</i></p> <ul style="list-style-type: none"> • 4 regions correct, which must include one of W only or S only, in terms of x
(b)	$36 + 10 + 16 + (30 - x) = 80$ $92 - x = 80$ $x = 12$	<p>Scale 5B (0, 2, 5)</p> <p>Accept correct answer without work.</p> <p><i>Partial Credit</i></p> <ul style="list-style-type: none"> • Work of merit, for example: some relevant use of 80 or x, or solves an incorrect linear equation correctly
(c)	<p>S1: 8 students have all 3 apps, <i>or equivalent</i></p> <p>S2: $24 = \#(I \cap S)$</p> <p>S3: 10 students have Instagram only, <i>or equivalent</i></p> <p>S4: $\#S > \#W$</p>	<p>Scale 15D (0, 7, 9, 12, 15)</p> <p><i>Low Partial Credit</i></p> <ul style="list-style-type: none"> • Work of merit in one of the four statements. <p><i>Mid Partial Credit</i></p> <ul style="list-style-type: none"> • 2 statements correct. <p><i>High Partial Credit</i></p> <ul style="list-style-type: none"> • 3 statements correct. <p><i>Full Credit –1</i></p> <ul style="list-style-type: none"> • Apply a * for a missing #, at most once.

Q7	Model Solution – 5 Marks	Marking Notes
<p>(a), (b)</p>	<p>(a) Any two sets A and B for which $A \subset B$, for example: $A = \{1,2,3\}$; $B = \{1,2,3\}$</p> <p style="text-align: center;">OR</p>  <p style="text-align: center;"><i>or any other valid example</i></p> <p>(b) Any two sets P and Q for which $P \cap Q = \{\}$, for example: $P = \{1,2,3,4\}$; $Q = \{5,6,7,8\}$</p> <p style="text-align: center;">OR</p>  <p style="text-align: center;"><i>or any other valid example</i></p>	<p>Scale 5D (0, 2, 3, 4, 5)</p> <p><i>Low Partial Credit</i></p> <ul style="list-style-type: none"> • Work of merit in either (a) or (b), for example: in (a), indication of a set fully inside a larger set; in (b), indication of mutually exclusive sets, or some explanation of what's left in P after taking away Q <p><i>Mid Partial Credit</i></p> <ul style="list-style-type: none"> • (a) or (b) correct. • Work of merit in both (a) and (b). <p><i>High Partial Credit</i></p> <ul style="list-style-type: none"> • (a) or (b) correct, and work of merit in the other part.

Q8	Model Solution – 30 Marks	Marking Notes
(a), (b)	<p>(a) Answer: <i>Lecky</i> Reason: Cuts y-axis at $(0, 0)$</p> <p style="text-align: center;">OR</p> <p style="text-align: center;">$b(x)$ starts at 50 <i>or any other valid reason</i></p> <p>(b) Domain: $0 \leq x \leq 1000$ Range: $50 \leq l(x) \leq 325$</p>	<p>Scale 15D (0, 7, 9, 12, 15) Accept 0, 1000 and 50, 325 in (b)</p> <p><i>Low Partial Credit</i></p> <ul style="list-style-type: none"> • Work of merit in either (a) or (b), for example: in (a), answer or reason correct; in (b), domain or range correct but in the wrong box; or a pair of values in either box with minimum or maximum correct. <p><i>Mid Partial Credit</i></p> <ul style="list-style-type: none"> • Work of merit in both (a) and (b) • Either (a) or (b) correct <p><i>High Partial Credit</i></p> <ul style="list-style-type: none"> • Either (a) or (b) correct, and work of merit in the other part. <p><i>Full Credit –1</i></p> <ul style="list-style-type: none"> • Apply a * to 275 given as the range in (b)
(c)	<p>(i) $100 < x < 800$</p> <p style="text-align: center;">OR</p> <p style="text-align: center;">“Between 100 and 800”</p> <p style="text-align: center;">OR</p> <p style="text-align: center;">(100, 800)</p> <p>(ii) “<i>Buzz</i> is cheaper if the number of units used is between these two values.” <i>or any other valid explanation</i></p>	<p>Scale 5D (0, 2, 3, 4, 5) Accept tolerance of ± 20 in (i) Note that answer to (i) must be in a valid form.</p> <p><i>Low Partial Credit</i></p> <ul style="list-style-type: none"> • Work of merit in either (i) or (ii), for example: in (i), 100 or 800 identified on graph; or relevant region of graph identified; in (ii), explanation of some merit. <p><i>Mid Partial Credit</i></p> <ul style="list-style-type: none"> • Either (i) or (ii) correct. • Work of merit in both (i) and (ii). <p><i>High Partial Credit</i></p> <ul style="list-style-type: none"> • Either (i) or (ii) correct, and work of merit in the other part.

Q8	Model Solution – 30 Marks	Marking Notes
(d)	<p>(i) Slope = $\frac{325-50}{1000-0}$ = $\frac{275}{1000}$ or 0.275 or $\frac{11}{40}$</p> <p>(ii) “The cost of electricity rises by €0.275 for every one unit increase of usage.” <i>or any other valid explanation</i></p>	<p>Scale 10D (0, 4, 6, 8, 10)</p> <p>Accept: “each unit costs €0.275”, or equivalent, in (ii)</p> <p><i>Low Partial Credit</i></p> <ul style="list-style-type: none"> • Work of merit in either (i) or (ii), for example: in (i), uses diagram to show understanding of slope; or $\frac{\text{Rise}}{\text{Run}}$ with some substitution; or $\frac{11}{20}$; in (ii), explanation of some merit. <p><i>Mid Partial Credit</i></p> <ul style="list-style-type: none"> • Either (i) or (ii) correct. • Work of merit in both (i) and (ii). <p><i>High Partial Credit</i></p> <ul style="list-style-type: none"> • Either (i) or (ii) correct, and work of merit in the other part.

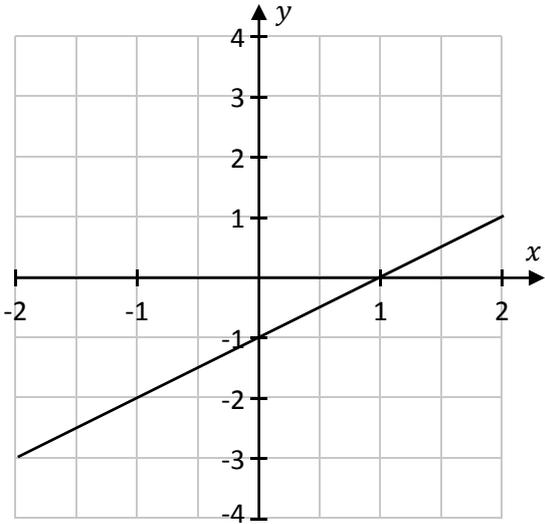
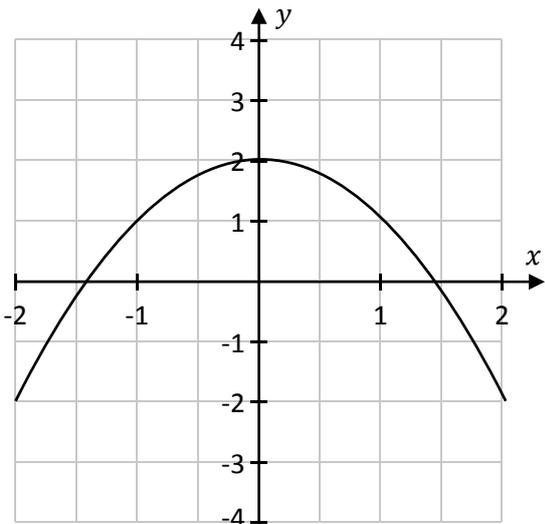
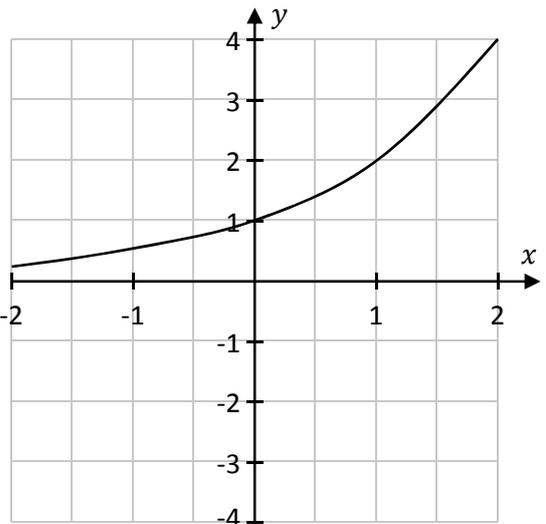
Q9	Model Solution – 25 Marks	Marking Notes																									
(a)	$x = \frac{-(-2) \pm \sqrt{(-2)^2 - 4(1)(-4)}}{2(1)}$ $x = \frac{2 \pm \sqrt{20}}{2}$ $x = 1 \pm \sqrt{5}$	<p>Scale 10C (0, 5, 7, 10)</p> <p>Accept “$1 + \sqrt{5}$ and $1 - \sqrt{5}$”.</p> <p>Consider the solution as having 3 steps:</p> <p>Step 1: Identifies a, or b, or c.</p> <p>Step 2: Full correct substitution into the quadratic formula.</p> <p>Step 3: Evaluates the quadratic formula.</p> <p><i>Low Partial Credit</i></p> <ul style="list-style-type: none"> • 1 step <p><i>High Partial Credit</i></p> <ul style="list-style-type: none"> • 2 steps • Correct answer without work <p><i>Full Credit –1</i></p> <ul style="list-style-type: none"> • Apply a * for the correct answer not in surd form ($-1.236 \dots$ and $3.236 \dots$) 																									
(b)	$(c + \sqrt{d})^2$ $= (c + \sqrt{d}) \cdot (c + \sqrt{d})$ $= c^2 + c\sqrt{d} + c\sqrt{d} + (\sqrt{d})^2$ $= c^2 + 2c\sqrt{d} + d$	<p>Scale 5C (0, 2, 3, 5)</p> <p><i>Low Partial Credit</i></p> <ul style="list-style-type: none"> • $(c + \sqrt{d}) \cdot (c + \sqrt{d})$ • c^2 • $c\sqrt{d}$ <p><i>High Partial Credit</i></p> <ul style="list-style-type: none"> • $c^2 + c\sqrt{d} + c\sqrt{d} + (\sqrt{d})^2$ 																									
(c)	<table border="1" style="width: 100%; text-align: center;"> <thead> <tr> <th></th> <th>N</th> <th>Z</th> <th>Q</th> <th>$\mathbb{R} \setminus \mathbb{Q}$</th> </tr> </thead> <tbody> <tr> <td>16</td> <td>Yes</td> <td>Yes</td> <td>Yes</td> <td>No</td> </tr> <tr> <td>$\sqrt{6}$</td> <td>No</td> <td>No</td> <td>No</td> <td>Yes</td> </tr> <tr> <td>$\frac{2}{3}$</td> <td>No</td> <td>No</td> <td>Yes</td> <td>No</td> </tr> <tr> <td>-4</td> <td>No</td> <td>Yes</td> <td>Yes</td> <td>No</td> </tr> </tbody> </table>		N	Z	Q	$\mathbb{R} \setminus \mathbb{Q}$	16	Yes	Yes	Yes	No	$\sqrt{6}$	No	No	No	Yes	$\frac{2}{3}$	No	No	Yes	No	-4	No	Yes	Yes	No	<p>Scale 10D (0, 4, 6, 8, 10)</p> <p>Note that 12 answers are required.</p> <p><i>Low Partial Credit</i></p> <ul style="list-style-type: none"> • 4 answers correct <p><i>Mid Partial Credit</i></p> <ul style="list-style-type: none"> • 1 row or 1 column fully correct <p><i>High Partial Credit</i></p> <ul style="list-style-type: none"> • 2 rows or 2 columns fully correct
	N	Z	Q	$\mathbb{R} \setminus \mathbb{Q}$																							
16	Yes	Yes	Yes	No																							
$\sqrt{6}$	No	No	No	Yes																							
$\frac{2}{3}$	No	No	Yes	No																							
-4	No	Yes	Yes	No																							

Q10	Model Solution – 10 Marks	Marking Notes
(a)	$2^{3+5+10} = 2^{18}$	<p>Scale 5B (0, 2, 5)</p> <p>Accept correct answer without work.</p> <p><i>No Credit</i></p> <ul style="list-style-type: none"> Evaluates the given number. <p><i>Partial Credit</i></p> <ul style="list-style-type: none"> Work of merit involving indices, for example: $18, 2^8, 2^{13}, 2^{15}$
(b), (c)	<p>(b) $8^{25} = (2^3)^{25} = 2^{75}$</p> <p>(c) $\sqrt{8} = (2^3)^{\frac{1}{2}} = 2^{\frac{3}{2}}$ or $2^{1.5}$</p>	<p>Scale 5D (0, 2, 3, 4, 5)</p> <p>Accept correct answer without work for both parts.</p> <p><i>No Credit</i></p> <ul style="list-style-type: none"> Evaluates the given number. <p><i>Low Partial Credit</i></p> <ul style="list-style-type: none"> Work of merit in either (b) or (c) involving indices, for example: 8 written as 2^3 in (b) or (c); or a square root written as a power of $\frac{1}{2}$ in (c). <p><i>Mid Partial Credit</i></p> <ul style="list-style-type: none"> Either (b) or (c) correct. Work of merit in both (b) and (c). <p><i>High Partial Credit</i></p> <ul style="list-style-type: none"> Either (b) or (c) correct, and work of merit in the other part.

Q11	Model Solution – 20 Marks	Marking Notes
(a)	$116 - 40 = 76$ $\frac{76}{4} = 19$ $40 - 19 = 21$ $40 + 19 = 59, \text{ etc.}$ <p>Answer: 21, 40, 59, 78, 97, 116</p>	<p>Scale 10C (0, 5, 7, 10)</p> <p>Accept correct answer without work.</p> <p><i>Low Partial Credit</i></p> <ul style="list-style-type: none"> Applies knowledge of linear sequences, for example: $116 - 40$, or indicates a common difference. <p><i>High Partial Credit</i></p> <ul style="list-style-type: none"> Finds or uses 19. Uses $\frac{76}{n}$ (for $n \in \mathbb{N}, n \neq 4$) and finishes correctly from one of the given values.
(b)	<p>1st differences:</p> $1, 3, 5, 8, 8, 11$ <p>2nd differences:</p> $2, 2, 3, 0, 3$ <p>1st differences should be:</p> $1, 3, 5, 7, 9, 11,$ <p>i.e. 2nd difference of 2.</p> <p>Answer: 5, 6, 9, 14, 21, 30, 41</p>	<p>Scale 10C (0, 5, 7, 10)</p> <p>Accept correct answer without work.</p> <p>Accept correct sequence not written in answer boxes.</p> <p><i>Low Partial Credit</i></p> <ul style="list-style-type: none"> Finds 2 first differences of given sequence. <p><i>High Partial Credit</i></p> <ul style="list-style-type: none"> Finds all 2nd differences of given sequence. Identifies 2 as the correct 2nd difference.

Q12	Model Solution – 35 Marks	Marking Notes									
(a)	$(n - 2)(n - 9)$ <p style="text-align: center;">OR</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td></td> <td style="text-align: center;">n</td> <td style="text-align: center;">-9</td> </tr> <tr> <td style="text-align: center;">n</td> <td style="text-align: center;">n^2</td> <td style="text-align: center;">$-9n$</td> </tr> <tr> <td style="text-align: center;">-2</td> <td style="text-align: center;">$-2n$</td> <td style="text-align: center;">18</td> </tr> </table> <p>so $(n - 2)(n - 9)$</p> <p style="text-align: center;">OR</p> $n^2 - 11n + 18$ $= n^2 - 9n - 2n + 18$ $= n(n - 9) - 2(n - 9)$ $= (n - 9)(n - 2)$		n	-9	n	n^2	$-9n$	-2	$-2n$	18	<p>Scale 5C (0, 2, 3, 5)</p> <p>Accept correct answer without work.</p> <p><i>Low Partial Credit</i></p> <ul style="list-style-type: none"> • Work of merit, for example: $(n - 2)$ or $(n - 9)$, or any pair of factors of 18, or $n^2 - 9n - 2n + 18$. • Some correct substitution into the quadratic formula <p><i>High Partial Credit</i></p> <ul style="list-style-type: none"> • Factors which multiply to give 2 correct coefficients of the given expression, including the signs, for example: $(n + 2)(n + 9)$, or $(n - 5)(n - 6)$. • $n(n - 9) - 2(n - 9)$ • Solves $n^2 - 11n + 18 = 0$ (without factorising).
	n	-9									
n	n^2	$-9n$									
-2	$-2n$	18									
(b)	$y(w - 1) + 1(w - 1)$ $= (w - 1)(y + 1) \text{ or } (1 - w)(-y - 1)$ <p style="text-align: center;">OR</p> $w(y + 1) - 1(y + 1)$ $= (y + 1)(w - 1) \text{ or } (1 - w)(-y - 1)$	<p>Scale 5C (0, 2, 3, 5)</p> <p><i>Low Partial Credit</i></p> <ul style="list-style-type: none"> • Work of merit, for example: a common factor identified from given expression <p><i>High Partial Credit</i></p> <ul style="list-style-type: none"> • $w(y + 1) - 1(y + 1)$ • Correct answer without work 									
(c)	$\frac{5}{3(4)-2} - \frac{7}{6(4)-12}$ $= \frac{5}{10} - \frac{7}{12}$ $= -\frac{5}{60} = -\frac{1}{12} \text{ or } -0.083 \dots$	<p>Scale 10B (0, 5, 10)</p> <p>Accept correct answer without work</p> <p><i>Partial Credit</i></p> <ul style="list-style-type: none"> • $3(4) - 2$ or $6(4) - 12$ 									
(d)	$\frac{(2e-3)(2e+3)}{(2e-3)(e+3)}$ $= \frac{(2e+3)}{(e+3)}$	<p>Scale 5D (0, 2, 3, 4, 5)</p> <p><i>Low Partial Credit</i></p> <ul style="list-style-type: none"> • Work of merit in either numerator or denominator <p><i>Mid Partial Credit</i></p> <ul style="list-style-type: none"> • Numerator or denominator factorised correctly <p><i>High Partial Credit</i></p> <ul style="list-style-type: none"> • Numerator or denominator factorised correctly, and work of merit in the other 									

Q12	Model Solution – 35 Marks	Marking Notes												
(e)	<p>Method 1:</p> $(x - 3)(ax^2 + bx + c)$ $= ax^3 + bx^2 + cx - 3ax^2 - 3bx - 3c$ <p>x^3 term: $a = 2$</p> <p>constant: $c = 4$</p> <p>x^2 term: $b - 3a = -13$</p> $b = -13 + 3(2) = -7$ <p style="text-align: center;">OR</p> <p>Method 2:</p> $ \begin{array}{r} 2x^2 - 7x + 4 \\ x - 3 \overline{) 2x^3 - 13x^2 + 25x - 12} \\ \underline{2x^3 - 6x^2} \\ -7x^2 + 25x - 12 \\ \underline{-7x^2 + 21x} \\ 4x - 12 \\ \underline{4x - 12} \\ 0 \end{array} $ <p>$\Rightarrow a = 2, b = -7, c = 4$</p> <p style="text-align: center;">OR</p> <p>Method 3:</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <tbody> <tr> <td></td> <td>$2x^2$</td> <td>$-7x$</td> <td>4</td> </tr> <tr> <td>x</td> <td>$2x^3$</td> <td>$-7x^2$</td> <td>$4x$</td> </tr> <tr> <td>-3</td> <td>$-6x^2$</td> <td>$21x$</td> <td>-12</td> </tr> </tbody> </table> <p>$\Rightarrow a = 2, b = -7, c = 4$</p>		$2x^2$	$-7x$	4	x	$2x^3$	$-7x^2$	$4x$	-3	$-6x^2$	$21x$	-12	<p>Scale 10D (0, 4, 6, 8, 10)</p> <p>Accept $2x^2 - 7x + 4$ as answer.</p> <p><i>Low Partial Credit</i></p> <ul style="list-style-type: none"> • Multiplication set up (Method 1) • Division set up (Method 2) • Array set up (Method 3) with either $2x^3$ or -12 placed correctly <p><i>Mid Partial Credit</i></p> <ul style="list-style-type: none"> • 1 coefficient correct <p><i>High Partial Credit</i></p> <ul style="list-style-type: none"> • 2 coefficients correct • Correct answer without work
	$2x^2$	$-7x$	4											
x	$2x^3$	$-7x^2$	$4x$											
-3	$-6x^2$	$21x$	-12											

Q13	Model Solution – 15 Marks	Marking Notes
	<p>Points on $y = x - 1$ are $(-2, -3)$ and $(2, 1)$.</p> 	<p>Scale 15D (0, 7, 9, 12, 15)</p> <p><i>Low Partial Credit</i></p> <ul style="list-style-type: none"> • Work of merit for 1 graph, for example: 1 point found, with supporting work; or y-intercept correct; or slope correct for line; or two points correct on graph. <p><i>Mid Partial Credit</i></p> <ul style="list-style-type: none"> • 1 correct graph and work of merit on 1 other graph. • Work of merit on all 3 graphs. <p><i>High Partial Credit</i></p> <ul style="list-style-type: none"> • 2 correct graphs and work of merit on 3rd • 5 points plotted for all 3 graphs <p><i>Full Credit –1</i></p> <ul style="list-style-type: none"> • Apply a * for one point incorrectly plotted
	<p>Points on $y = 2 - x^2$ are: $(-2, -2)$; $(-1, 1)$; $(0, 2)$; $(1, 1)$; $(2, -2)$.</p> 	<p>Points on $y = 2^x$ are: $(-2, 0.25)$; $(-1, 0.5)$; $(0, 1)$; $(1, 2)$; $(2, 4)$.</p> 

Q14	Model Solution – 20 Marks	Marking Notes
(a), (c)	(a) $360 + 180 = 540^\circ$ (c) $540 + 180 = 720^\circ$ (c) $\frac{360}{4} = 90^\circ$ $\frac{540}{5} = 108^\circ$ $\frac{720}{6} = 120^\circ$	Scale 10D (0, 4, 6, 8, 10) Accept correct answers without units (degree symbol). <i>Low Partial Credit</i> <ul style="list-style-type: none"> 1 of the 5 values correct. <i>Mid Partial Credit</i> <ul style="list-style-type: none"> (a) or (c) correct. <i>High Partial Credit</i> <ul style="list-style-type: none"> (a) or (c) correct, and 1 value correct in the other part.
(b)	$180(n - 2)$ [degrees] OR $180n - 360$ [degrees]	Scale 5B (0, 2, 5) Accept correct answer without units. Accept correct formula in words. <i>Partial Credit</i> <ul style="list-style-type: none"> Work of merit, for example: $180n$, or $360n - 360$.
(d)	$\frac{180(n-2)}{n}$ [degrees] OR $\frac{180n-360}{n}$ [degrees]	Scale 5B (0, 2, 5) Accept correct answer without units. Accept correct formula in words. <i>Partial Credit</i> <ul style="list-style-type: none"> Work of merit, for example: $\frac{k}{n}, k \in \mathbb{R}$.

Q15	Model Solution – 5 Marks	Marking Notes
	Answer: C Reason: Some x values have more than one y value <i>or any other valid reason</i>	Scale 5B (0, 2, 5) <i>Partial Credit</i> <ul style="list-style-type: none"> C identified as answer Shows understanding of the relevant feature of a function, for example: vertical line drawn.