Coimisiún na Scrúduithe Stáit
State Examinations Commission

JUNIOR CERTIFICATE EXAMINATION

2012

MARKING SCHEMES

MATHEMATICS HIGHER LEVEL

JUNIOR CERTIFICATE EXAMINATION

2012

MARKING SCHEME

MATHEMATICS HIGHER LEVEL PAPER 1

MARKING SCHEME
JUNIOR CERTIFICATE EXAMINATION 2012
MATHEMATICS - HIGHER LEVEL - PAPER 1

GENERAL GUIDELINES FOR EXAMINERS

1. Penalties of three types are applied to candidates' work as follows:
   - Blunders - mathematical errors/omissions (-3)
   - Slips- numerical errors (-1)
   - Misreadings (provided task is not oversimplified) (-1).

   Frequently occurring errors to which these penalties must be applied are listed in the scheme. They are labelled: B1, B2, B3,…, S1, S2,…, M1, M2,…etc. These lists are not exhaustive.

2. When awarding attempt marks, e.g. Att(3), note that
   - any *correct, relevant* step in a part of a question merits at least the attempt mark for that part
   - if deductions result in a mark which is lower than the attempt mark, then the attempt mark must be awarded
   - a mark between zero and the attempt mark is never awarded.

3. Worthless work is awarded zero marks. Some examples of such work are listed in the scheme and they are labelled as W1, W2,…etc.

4. The phrase "hit or miss" means that partial marks are not awarded – the candidate receives all of the relevant marks or none.

5. The phrase "and stops" means that no more work is shown by the candidate.

6. Special notes relating to the marking of a particular part of a question are indicated by an asterisk. These notes immediately follow the box containing the relevant solution.

7. The sample solutions for each question are not intended to be exhaustive lists – there may be other correct solutions.

8. Unless otherwise indicated in the scheme, accept the best of two or more attempts – even when attempts have been cancelled.

9. The *same* error in the *same* section of a question is penalised *once* only.

10. Particular cases, verifications and answers derived from diagrams (unless requested) qualify for attempt marks at most.

11. A serious blunder, omission or misreading results in the attempt mark at most.

12. Do not penalise the use of a comma for a decimal point, *e.g.* €5·50 may be written as €5,50.

BONUS MARKS FOR ANSWERING THROUGH IRISH

Bonus marks are applied separately to each paper as follows:

If the mark achieved is 225 or less, the bonus is 5% of the mark obtained, rounded **down**.
(e.g. 198 marks $\times$ 5% = 9.9 $\Rightarrow$ bonus = 9 marks.)

If the mark awarded is above 225, the following table applies:

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

QUESTION 1

Part (a)	**10 marks**	**Att (2,2)**
Part (b)	**20 marks**	**Att (3,3)**
Part (c)	**20 marks**	**Att (2,3,2)**

Part (a) **10(5,5) marks** **Att (2,2)**

(a)	**(i)**	List the divisors of 30.
	(ii)	State which of these divisors are prime numbers.

(a) (i) **5 marks** **Att 2**

Divisors of 30 → 1, 2, 3, 5, 6, 10, 15, 30.

* Accept correct answer for full marks. No work required, no ✍

Slips (-1)
S1 Each incorrect or missing number to a maximum of -3, must have at least one correct

Misreadings (-1)
M1 Misreads 30, but continues correctly, provided oversimplification does not occur

Attempts (2 marks)
A1 Any correct divisor
A2 Any relevant step

Worthless (0)
W1 Incorrect answer, but note A1
W2 Multiples of 30

(a) (ii) **5 marks** **Att 2**

Prime divisors of 30 → 2, 3, 5.

* Answer may be dependent on part **(i)**

Slips (-1)
S1 Each incorrect or missing prime number to a maximum of -3, must have at least one correct
S2 Includes 1 as a prime number

Attempts (2 marks)
A1 Any correct prime divisor
A2 Shows some knowledge of a prime number

Worthless (0)
W1 Incorrect answer with no work of merit

Part (b) **20 (10,10) marks** **Att (3,3)**

(i) €900 is invested for two years at 3% per annum compound interest.

✍ Find the value of the investment at the end of the second year

(ii) John has a gross weekly wage of €600.
After tax his net weekly wage is €554.

✍ Calculate his tax credits if he is taxed at the standard rate of 20%.

(b) (i) **10 marks** **Att 3**

I

$P_1 = €900$ $\quad I_1 = \frac{P \times R}{100} = \frac{900 \times 3}{100}$ **3m**

$= €27$ **4m**

$P_2 = €900 + €27 = €927$ $\quad I_2 = \frac{P \times R}{100} = \frac{927 \times 3}{100} = €27{\cdot}81$ **7m**

$A_2 = €927 + €27{\cdot}81$ **7m**

$= €954{\cdot}81$ **10m**

II

$A = P\,(1 + i)^t$

$A = €900\left(1 + \frac{3}{100}\right)^2$ or $€900\,(1 + \cdot 03)^2$ **3m**

$A = €900\,(1 \cdot 03)^2$ **4m**

$A = €900(1{\cdot}0609)$ **7m**

$A = €954{\cdot}81$ **10m**

* Do not penalise for the omission of € symbol
* Ignore missing brackets if final answer is not affected
* Final answer of €954 is 4 marks

Blunders (-3)

B1 Correct answer, no work shown ✍
B2 3% of an incorrect number
B3 Decimal error
B4 Incorrect operation
B5 Mathematical error
B6 Error in squaring
B7 Error in formula
B8 Precedent error
B9 Fails to calculate final step

Slips (-1)
S1 Numerical error to a max of -3

Misreadings (-1)
M1 Misreads a digit provided it doesn't oversimplify the question

Attempts (3 marks)

A1 Relevant correct formula which is not in log tables
A2 Finds 3% of some number other than €900 and stops
A3 Divides by 100
A4 900×3
A5 $\frac{P \times R \times T}{100} = 54$, oversimplification
A6 Identifies P = €900 and/or R =3% or ·03
A7 $3\% = \frac{3}{100}$ or ·03
A8 Any correct substitution
A9 Any relevant step

Worthless (0)

W1 Incorrect answer no work shown
W2 $F = P\,(1 + i\,)^{t}$ with no correct substitution

(b) (ii) **10 marks** **Att 3**

I

Gross income	=	€600	
Net income	=	€554	.... **Given in question**
Tax paid	=	€600 − €554	**3 m**
	=	€46	**4 m**
Tax @20%	=	20% of €600	
	=	€120	**7m**
Tax credits	=	€120 – €46	
	=	€74	**10m**

Steps are interchangeable:

Tax @20%	=	20% of €600	**3m**
	=	€120	**4m**
Tax paid	=	€600 − €554	**4m**
	=	€46	**7 m**
Tax credits	=	€120 – €46	**7m**
	=	€74	**10m**

II

Tax @20%	=	20% of €600	**3m**
	=	€120	**4m**
		€600 − €120	
	=	€480	**7m**
		€554 − €480	
	=	€74	**10m**

Blunders (-3)

B1 Correct answer, no work shown ✍
B2 Decimal error
B3 Incorrect operation
B4 Inversion
B5 Mathematical error
B6 Finds 20% of an incorrect figure
B7 Fails to calculate final step

Slips (-1)

S1 Numerical error to a max of -3

Misreadings (-1)

M1 Misreads a digit provided it doesn’t oversimplify the question

Attempts (3 marks)

A1 Finds 20% correctly of a figure other than €600 and stops
A2 20% = $\frac{20}{100}$ or equivalent
A3 Divides by 100
A4 Shows some knowledge of tax credits *e.g.* writes “Tax payable = total tax – tax credits”
A5 Any relevant step

Worthless (0)

W1 Incorrect answer no work shown
W2 600 × 554
W3 No work of merit

Part (c)	**20 (5,10,5) marks**	**Att (2,3,2)**

(i) ✍ By rounding to the nearest whole number, estimate the value of

$$\frac{3\cdot 89\times 7\cdot 24\ -\ \sqrt{8\cdot 94}}{8\cdot 52-3\cdot 65}$$

(ii) ✍ Evaluate $\dfrac{3\cdot 89\times 7\cdot 24\ -\ \sqrt{8\cdot 94}}{8\cdot 52-3\cdot 65}$, correct to two decimal places.

(iii) ✍ Simplify $\sqrt{5}\left(\sqrt{2}+\sqrt{5}\right)-\sqrt{8}\left(\sqrt{2}-\sqrt{5}\right)$ without the use of a calculator.
Express your answer in the form $a+b\sqrt{c}$, where a, b, c $\in \mathbb{N}$.

(c) (i)	**5 marks**	**Att 2**

	$\dfrac{4\times 7-\sqrt{9}}{9-4}$	**2m**
$=$	$\dfrac{28-3}{5}$	**2m**
$=$	$\dfrac{25}{5}$	**2m**
$=$	5	**5m**

Blunders (-3)

B1 Correct answer, no work shown ✍
B2 Rounds incorrectly, once if consistent
B3 Incorrect operation
B4 Inversion
B5 Mathematical error
B6 Precedent error
B7 Square root error
B8 Invalid cancellation
B9 Sign error
B10 Fails to calculate final step, stops at $\frac{25}{5}$

Slips (-1)

S1 Numerical errors to a max of -3

Misreadings (-1)

M1 Misreads a digit provided it doesn't oversimplify the question

Attempts (2 marks)

A1 Some correct rounding
A2 5·17 with work

Worthless (0)

W1 Incorrect answer, no work shown *e.g.* 5·17 **without** work
W2 No work of merit

(c) (ii) **10 marks** **Att 3**

$$\frac{3\cdot 89 \times 7\cdot 24 \ - \ \sqrt{8\cdot 94}}{8\cdot 52 - 3\cdot 65}$$

$= (28{\cdot}1636 - 2{\cdot}989983278) \div 4{\cdot}87$	**4m**
$= 25{\cdot}17361672 \div 4{\cdot}87$	**7m**
$= 5{\cdot}16912$	**9m**
$= 5{\cdot}17$	**10m**

Blunders (-3)

B1 Correct answer, no work shown ✍
B2 Decimal error
B3 Incorrect operation
B4 Inversion
B5 Mathematical error
B6 Precedent error
B7 Square root error
B8 Sign error
B9 Stops at 25·17361672 ÷ 4·87

Slips (-1)
S1 Numerical errors to a max of -3
S2 Stops at 5·169 or 5·1691 or 5·16912 or similar
S3 Early rounding if it affects final answer, but note A2

Misreadings (-1)
M1 Misreads a digit provided it doesn't oversimplify the question

Attempts (3 marks)
A1 Some correct calculation
A2 Rounds to whole numbers and continues
A3 Any relevant step

Worthless (0)
W1 Incorrect answer, no work shown
W2 No work of merit

(c) (iii) **5 marks** **Att 2**

$$\sqrt{5}\left(\sqrt{2}+\sqrt{5}\right) - \sqrt{8}\left(\sqrt{2}-\sqrt{5}\right)$$

$=$	$\sqrt{10}+\sqrt{25}\ -\sqrt{16}+\sqrt{40}$	**2m**
$=$	$\sqrt{10}+5-\ 4+2\sqrt{10}$	**2m**
$=$	$1+3\sqrt{10}$	**5m**

Blunders (-3)

B1 Correct answer, no work shown ✍
B2 Distribution error
B3 Sign error
B4 Error in surds, once if consistent
B5 Mathematical error
B6 Fails to finish

Slips (-1)

S1 Numerical error to a max of -3

Misreadings (-1)

M1 Misreads a digit provided it doesn't oversimplify the question

Attempts (2 marks)

A1 10·486832298, no surds used, with work shown
A2 Any relevant attempt at handling surds
A3 √ = power of ½
A4 Any relevant work

Worthless (0)

W1 Incorrect answer no work shown
W2 √5 = 2·236067977 and/or √8 = 2·828427125 and/or √2 = 1·414213562 and stops
W3 No work of merit

QUESTION 2

Part (a)	**10 marks**	**Att 3**
Part (b)	**20 marks**	**Att (3,2,2)**
Part (c)	**20 marks**	**Att (3,2,2)**

Part (a)	**10 marks**	**Att 3**

Fuel consumption in a car is measured in litres per 100 km.
Alan's car travels 1250 km on a tank of 68 litres.

✍ Calculate his car's fuel consumption in litres per 100 km.

(a)	**10 marks**	**Att 3**

I

1250 ÷ 100	**3m**
= 12·50	**4m**
68 litres for 12·50 '100km' → $\frac{68}{12 \cdot 50}$	**7m**
= 5·44 litres / 100km.	**10m**

II

1250 km = 68 litres ....given in question

1 km = 68 ÷ 1250	**3m**
= ·0544	**4m**
100km = ·0544 × 100	**7m**
= 5·44 litres / 100km	**10m**

* $\frac{68}{1250}$ × 100 and stops is worth 4m; ·1838 with work is 7m; 18·38 with work is 3m

Blunders (-3)

B1 Correct answer, no work shown ✍
B2 Decimal error
B3 Incorrect multiplier (check method)
B4 Incorrect division
B5 Mathematical error
B6 Inversion
B7 Incorrect operation
B8 Fails to complete last step

Slips (-1)

S1 Numerical errors to a max of -3

Misreadings (-1)

M1 Misreads a digit provided it doesn't oversimplify the question

Attempts (3 marks)

A1 Multiplies or divides by 100
A2 1250 ÷ 68
A3 Some knowledge of relationship between fuel consumption and distance indicated
A4 Any relevant step

Worthless (0)

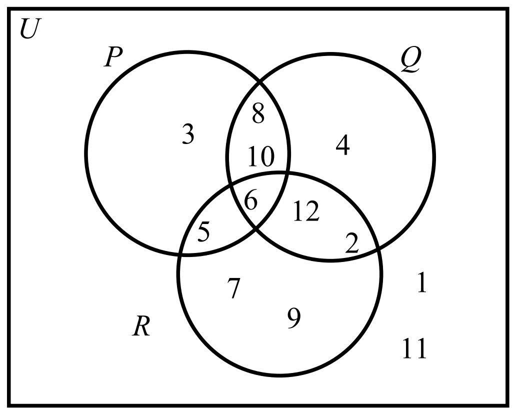
W1 Incorrect answer no work shown
W2 No work of merit

Part (b) **20 (10,5,5) marks** **Att (3,2,2)**

$U = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12\}$ is the universal set.
$P = \{3, 5, 6, 8, 10\}$, $Q = \{2, 4, 6, 8, 10, 12\}$ and $R = \{2, 5, 6, 7, 9, 12\}$
are three subsets of U.
(i) Represent the above information on a Venn diagram.
Hence list the elements of:
(ii) $(P \cup Q \cup R)'$
(iii) $(P \cap Q) \setminus R$.

(b) (i) **10 marks** **Att 3**

Venn diagram:



* Ignore notation
* Sets *P, Q, R* may be positioned differently from above

Slips (-1)
S1 Each incorrect or missing or misplaced element in Venn diagram each time but note A2
S2 Universal box not drawn on diagram

Misreadings (-1)
M1 Misreads a digit provided it doesn’t oversimplify the question

Attempts (3 marks)
A1 Draws a Venn diagram with three intersecting circles and stops
A2 Any correct entry
A3 Universal box with two intersecting circles
A4 Three intersecting circles
A5 Universal box with a correct entry

Worthless (0)
W1 Rectangle only
W2 Circle with no correct entry
W3 Two intersecting circles with no correct entry

(b) (ii) **5 marks** **Att 2**

$(P \cup Q \cup R)' \quad = \quad \{1, 11\}$

* Answer may be dependent on candidate's answer to **(b)(i)**
* Answer may be indicated on diagram
* Ignore notation

Blunders (-3)
B1 Elements of $(P \cup Q \cup R)$ given as answer *i.e.* {2, 3, 4, 5, 6, 7, 8, 9, 10, 12}

Slips (−1)
S1 Each incorrect or missing or misplaced element to a maximum of -3, must have at least one element correct; note B1

Attempts (2 marks)
A1 One correct element
A2 Any relevant step

Worthless (0)
W1 Incorrect answer with no work of merit, note B1
W2 { } but note *1
W3 Draws diagram again, with no further work of merit

(b) (iii) **5 marks** **Att 2**

$(P \cap Q) \setminus R \quad = \quad \{8, 10\}$

*Answer may be dependent on candidate's answer to **(b)(i)**
*Answer may be indicated on diagram
*Ignore notation

Slips (-1)
S1 Each incorrect or missing or misplaced element to a maximum of -3, must have at least one element correct

Attempts (2 marks)
A1 Shades/indicates the correct region on Venn diagram, but elements not clearly identified
A2 $(R \cap Q) \setminus P$ = {2,12} or candidate's equivalent or $(P \cap R) \setminus Q$ = {5} or candidate's equivalent
A3 Any relevant step

Worthless (0)
W1 { } but note *1
W2 Draws diagram again, with no further work of merit
W3 Incorrect answer with no work of merit, note A2

Part (c)	20 (10,5,5) marks	Att (3,2,2)

An electronics company imports tablet computers from China at a cost of 696 Yuan (元) per tablet.

(i) ✍ Find the cost of each tablet, in euro, if €1 = 8·7 元.

The company must also pay a shipping cost on each tablet imported.
By selling a tablet at €105·40, the company can make a profit of 24%.

(ii) ✍ Find the shipping cost per tablet.

The company imports 1000 tablets from China. It sells 600 of them at €105·40 each (i.e. at a profit of 24%) and the remainder at a profit of 15%.

(iii) ✍ Find the overall profit, in euro, made by the company.

(c) (i)	10 marks	Att 3

I

Cost in euro	=	$\dfrac{696}{8\cdot7}$	**7m**
	=	€80	**10m**

II

€1 = 8·7 元 Given	
€1 ÷ 8·7 = 元	3m
·114942528	**4m**
·114942528 × 696	**7m**
= €80	**10m**

* € symbol not necessary in answer
* (€ 1 ÷ 8·7) × 696 is worth 4m

Blunders (-3)

B1 Correct answer, no work shown ✍
B2 Decimal error
B3 Incorrect numerator
B4 Incorrect denominator
B5 Mathematical error
B6 Inversion
B7 Fails to finish

Slips (-1)

S1 Numerical error to a max of -3
S2 Early rounding of decimal if it affects final answer

Misreadings (-1)

M1 Misreads a digit provided it doesn’t oversimplify the question

Attempts (3 marks)

A1 Any relevant step

Worthless (0)

W1 Incorrect answer no work shown
W2 No work of merit

(c) (ii) **5 marks** **Att 2**

I

$124\% = €105{\cdot}40$
$1\% = 105{\cdot}40 \div 124 = {\cdot}85$
$100\% = {\cdot}85 \times 100 = €85$
$€85 - €80 = €5$ shipping cost

II

$(€80 + x)\,(1{\cdot}24) = €105{\cdot}40$
$99{\cdot}20 + 1{\cdot}24\,x = 105{\cdot}40$
$1{\cdot}24\,x = 105{\cdot}40 - 99{\cdot}20$
$1{\cdot}24\,x = 6{\cdot}20$
$x = 6{\cdot}20 \div 1{\cdot}24$
$x = €5$

III

Each tablet with profit = $€80 \times 124\% = €99{\cdot}20$
$€105{\cdot}40 - €99{\cdot}20$
Shipping charge = $€6{\cdot}20 \div 1{\cdot}24 = €5$

IV

Profit + 124% shipping charge = $€105{\cdot}40 - €80 = €25{\cdot}40$
Profit = €25·40 – 124% shipping charge   Shipping charge = x
Profit = $€25{\cdot}40 - 1{\cdot}24\,x$

$\%\ \text{Profit} = \frac{Profit}{Cost\ Price} \times 100$

$24 = \frac{25{\cdot}40 - 1{\cdot}24\,x}{80} \times 100$

$24 = (25{\cdot}40 - 1{\cdot}24\,x) \times \frac{100}{80}$

$24 \div \frac{100}{80} = 25{\cdot}40 - 1{\cdot}24\%$

$24 \times \frac{80}{100} = 25{\cdot}40 - 1{\cdot}24\,x$

$19{\cdot}20 = 25{\cdot}40 - 1{\cdot}24\,x$
$19{\cdot}20 - 25{\cdot}40 = -1{\cdot}24\,x$
$-6{\cdot}20 = -1{\cdot}24\,x$
124% shipping charge = €6·20
Shipping charge $= €6{\cdot}20 \div 1{\cdot}24$
$= €5$

* Accept candidate's figure from **(c)(i)**

Blunders (-3)

B1 Correct answer, no work shown ✍
B2 Decimal error
B3 Incorrect operation
B4 Distribution error
B5 Mathematical error
B6 Incorrect value for cost price based on previous figures
B7 Fails to finish

Slips (-1)
S1 Numerical errors to a max of -3

Misreadings (-1)
M1 Misreads a digit provided it doesn't oversimplify the question

Attempts (2 marks)
A1 Shows some knowledge of % profit
A2 Any relevant step

Worthless (0)
W1 Incorrect answer no work shown
W2 No work of merit

(c) (iii) **5 marks** **Att 2**

$600 \times 105{\cdot}40$	=	63,240
$400 \times 85 \times 1{\cdot}15$	=	<u>39,100</u>
Total	=	102,340
85×1000	=	<u>85,000</u>
Overall profit	=	€17,340

* Accept candidate's values from **(c)(i)** and **(ii)**
* Candidates may use other variations in calculating the overall profit

Blunders (-3)

B1 Correct answer, no work shown ✍
B2 Decimal error
B3 Incorrect operation
B4 Mathematical error
B5 Fails to finish

Slips (-1)
S1 Numerical errors to a max of 3

Misreadings (-1)
M1 Misreads a digit provided it doesn't oversimplify the question

Attempts (2 marks)
A1 Multiplies by 1000
A2 Multiplies by 600
A3 Multiplies by 400
A4 Finds 15% or states 15% = $\frac{15}{100}$
A5 Any relevant step

Worthless (0)
W1 Incorrect answer no work shown
W2 No work of merit

QUESTION 3

Part (a)	**10 marks**	**Att 3**
Part (b)	**20 marks**	**Att (2,3,2)**
Part (c)	**20 marks**	**Att (2,2,2,2)**

Part (a) **10 marks** **Att 3**

✍ Given that 1 billion is a thousand million, find the sum of €3·6 billion and €700 million.

Give your answer in the form $a \times 10^n$ where $n \in \mathbb{N}$ and $1 \leq a < 10$.

(a) **10 marks** **Att 3**

I

$3{\cdot}6 \times 10^9 + 700 \times 10^6 = 3{\cdot}6 \times 10^9 + 0{\cdot}7 \times 10^9$ **4m** $= 4{\cdot}3 \times 10^9$

II

€3,600,000,000 + €700,000,000 = €4,300,000,000 **4m** $= 4{\cdot}3 \times 10^9$

III

€3·6 billion + €0·7 billion = €4·3 billion **4m** $= 4{\cdot}3 \times 10^9$

IV

$3{\cdot}6 \times 10^9 + 7 \times 10^8$ (or equivalent)

= 3,600,000,000 + 700,000,000

= 4,300,000,000 **4m** $= 4{\cdot}3 \times 10^9$

Blunders (-3)

B1 Correct answer, no work shown ✍
B2 Decimal error
B3 Answer not given in correct form
B4 Index error
B5 Mathematical error

Misreadings (-1)

M1 Misreads a digit provided it doesn't oversimplify the question

Attempts (3 marks)

A1 Indicates some knowledge of indices *e.g.* gets 10^9
A2 Converts either expression to a whole number and stops
A3 Writes 0·7 billion and stops
A4 Any relevant step

Worthless (0)

W1 Incorrect answer, no work shown
W2 Attempts to add and shows no knowledge of indices, but note A1
W3 No work of merit

Part (b)	**20 (5,10,5) marks**	**Att (2,3,2)**

(i)	✍	Simplify	$\dfrac{6x^2-17x+12}{3x-4}$.
(ii)	✍	Factorise	$4c^2-3d-2cd+6c$.
(iii)	✍	Express in its simplest form:	$\dfrac{5}{x-3} - \dfrac{3}{x-2}$.

(b) (i)	**5 marks**	**Att 2**

I

$$\frac{(3x-4)(2x-3)}{3x-4} \quad = \quad 2x-3$$

II

$$\begin{array}{r|l} & \quad 2x-3 \\ \hline 3x-4 & 6x^2-17x+12 \\ & \underline{6x^2-\ \ 8x} \\ & \quad -\ 9x+12 \\ & \quad \underline{-\ 9x+12} \\ & \qquad\qquad 0 \end{array}$$

III

$(6x^2-17x+12) \div (3x-4)$
$(6x^2-9x-8x+12) \div (3x-4)$
$[3x(2x-3)-4(2x-3)] \div (3x-4)$
$[(3x-4)(2x-3)] \div (3x-4)$
$= 2x-3$

IV

$(6x^2-17x+12) \div (3x-4)$
$(6x^2-8x-9x+12) \div (3x-4)$
$[2x(3x-4)-3(3x-4)] \div (3x-4)$
$[(2x-3)(3x-4)] \div (3x-4)$
$= 2x-3$

* $(2x-3)(3x+4)$ and continues is one blunder - B4. It will also incur B6 ***or*** B7.
All other attempts to factorise apply B2, B3 and/or B4.

Blunders (-3)

- B1 Correct answer, no work shown ✍
- B2 Incorrect factors of $6x^2$ in method **I**
- B3 Incorrect factors of +12 in method **I**
- B4 Incorrect factors leading to an incorrect middle term in method I
- B5 Mathematical error
- B6 Incorrect cancellation
- B7 Fails to finish *i.e.* no cancellation in method **I**

Slips (-1)
S1 Numerical errors to a maximum of -3

Attempts (2 marks)
A1 Some effort at factorising
A2 Sets up division
A3 Multiplies instead of dividing, with at least one correct term
A4 Finds guide number (72) in methods **III** and **IV** and stops
A5 Quadratic with some correct substitution
A6 Sets up quadratic and identifies *a*, *b* or *c*
A7 Uses quadratic formula and stops at correct roots ($x = \frac{3}{2}$ and $x = \frac{4}{3}$)
A8 Any relevant step

Worthless (0)
W1 Incorrect answer, no work shown
W2 ( ) ( )
W3 Work of no merit

(b) (ii) **10 marks** **Att 3**

I		**II**	
$4c^2 - 3d - 2cd + 6c$	Given	$4c^2 - 3d - 2cd + 6c$	Given
$4c^2 + 6c - 2cd - 3d$	**3m**	$4c^2 - 2cd + 6c - 3d$	**3m**
$2c(2c + 3) - d(2c + 3)$	**7m**	$2c(2c - d) + 3(2c - d)$	**7m**
$(2c + 3)(2c - d)$	**10m**	$(2c - d)(2c + 3)$	**10m**

* Accept any of the following for full marks with work (with or without brackets):

$(2c - d)$ and $(2c + 3)$	[the word 'and' is written down]
$(2c - d)$ or $(2c + 3)$	[the word 'or' is written down]
$(2c - d)$, $(2c + 3)$	[a comma is used]

Blunders (-3)
B1 Correct answer, no work shown ✍
B2 Error in factorising any pair of terms, apply once if consistent.
B3 Incorrect last step *e.g* $2cd(2c - 3)$
B4 Incorrect common factor and continues *e.g.* $2c(2c - 3) + d(2c - 3)$
B5 Incorrect common factor and continues *e.g.* $2c(2c + 3) - d(2c - 3)$. B3 or B6 will also apply.
B6 Fails to finish, stops at $2c(2c + 3) - d(2c + 3)$ or similar

Slips (-1)
S1 $(2c - d) + (2c + 3)$
S2 $(2c - d) - (2c + 3)$

Attempts (3 marks)
A1 Some effort at factorising *e.g.* groups or attempts to pair

Worthless (0)
W1 Incorrect answer, no work shown
W2 No work of merit

(b) (iii) **5 marks** **Att 2**

$$\frac{5}{x-3} - \frac{3}{x-2}$$

$$= \frac{5(x-2)-3(x-3)}{(x-3)(x-2)} \qquad \textbf{2m}$$

$$= \frac{5x-10-3x+9}{(x-3)(x-2)} \qquad \textbf{2m}$$

$$= \frac{2x-1}{(x-3)(x-2)} \qquad \textbf{5m}$$

Blunders (-3)

B1 Correct answer, no work shown ✍

B2 Incorrect common denominator or mishandles common denominator

B3 Mishandles numerator

B4 Distribution error

B5 Mathematical error

B6 Fails to combine like terms in final answer

B7 Reads as $\frac{5}{x-3}+\frac{3}{x-2}$ and continues

Slips (-1)

S1 Numerical slips to a max of -3

Attempts (2 marks)

A1 Correct common denominator and stops

A2 No denominator used

A3 Any relevant step

Worthless (0)

W1 Incorrect answer, no work shown

W2 $\frac{5}{x-3}-\frac{3}{x-2}=\frac{2}{-1}$ *or* $\frac{2}{2x-5}$ *or* $\frac{2}{5}$ *or* $\frac{2}{-5}$ *etc*

W3 No work of merit

Part (c) **20 (5,5,5,5) marks** **Att (2,2,2,2)**

Roisín cycled from Wicklow to Bray, a distance of 30 km. She left Wicklow at 10:30 and arrived in Bray at 12:20, having stopped in Greystones for 20 minutes. Greystones is 22 km from Wicklow. **(i)** Roisín's average speed between Wicklow and Greystones was x km/h. Write an expression in x for the time taken for this part of her journey. **(ii)** Her average speed for the second part of her journey, between Greystones and Bray, was 6 km/h slower than her speed between Wicklow and Greystones. Write an expression in x for the time it took to complete the second part of her journey. **(iii)** Write an equation in x to represent the above information. **(iv)** ✍ Solve the equation to find Roisín's speed for each part of the journey.

(c) (i) **5 marks** **Att 2**

Time (1) $= \dfrac{22}{x}$

* Accept correct answer for full marks. No work required, no ✍

Blunders (-3)

B1 Inversion $\frac{x}{22}$

Attempts (2 marks)

A1 Writes 22 and/or x

A2 Speed $= \frac{Distance}{Time}$

Worthless (0)

W1 Incorrect answer, no work shown

(c) (ii) **5 marks** **Att 2**

Time (2) $= \dfrac{8}{x-6}$

* Accept correct answer for full marks. No work required, no ✍

Blunders (-3)

B1 Inversion $\frac{x-6}{8}$

B2 Uses $x + 6$

B3 Incorrect operation

Attempts (2 marks)

A1 Any combination of two of the following x, 6, 8

A2 Speed $= \frac{Distance}{Time}$

A3 30 – 22 or 8

A4 Any relevant step

Worthless (0)

W1 Incorrect answer, no work shown; note A3

(c) (iii) **5 marks** **Att 2**

12:20 – 20 minutes – 10:30 = 1 hour 30 minutes	**2m**
= 1·5 hours	**2m**
Total time $\dfrac{22}{x} + \dfrac{8}{x-6} = 1{\cdot}5$	**5m**

* Accept candidates' expressions from **(c)(i)** and **(c)(ii)**

* Accept correct answer for full marks. No work required, no ✍

* If no work, or no work of merit, at parts (i) and/or (ii) but states above, award *Att 2* and *Att 2* from parts **(c)(i)**, and/or **(c)(ii)** here

Blunders (-3)

B1 Sign error in setting up equation *e.g.* has $\frac{22}{x} - \frac{8}{x-6} = \frac{3}{2}$

B2 Expression not equal to 1·5 or $\frac{3}{2}$, but note S1

B3 Uses 1·3

Slips (-1)

S1 $\frac{22}{x} + \frac{8}{x-6} = 90$

Attempts (2 marks)

A1 Incorrect expression but uses data from **(c) (i)** and **(c) (ii)**

A2 Constructs an equation or expression using at least two of the following:
$\frac{3}{2}$, answer **(c) (i)**, answer **(c) (ii)**

A3 Attempt to subtract times

A4 Any relevant step

Worthless (0)

W1 1·3 only

W2 No work of merit

(c) (iv) **5 marks** **Att 2**

I

$\frac{22}{x} + \frac{8}{x-6} = 1.5$

$22x - 132 + 8x = 1 \cdot 5x^2 - 9x$

$1.5x^2 - 39x + 132 = 0$

$x^2 - 26x + 88 = 0$

$(x-4)(x-22) = 0$

$x = 4 \qquad x = 22$

II

$\frac{22}{x} + \frac{8}{x-6} = \frac{3}{2}$

$\frac{22(2)(x-6)+8(2)(x)=3x(x-6)}{x(x-6)(2)}$ **2m**

$44x - 264 + 16x = 3x^2 - 18x$

$3x^2 - 78x + 264 = 0$

$x^2 - 26x + 88 = 0$

$(x-4)(x-22) = 0$

$x = 4 \qquad x = 22$

$x = 22$ → speed (1) = 22 → speed (2) $x - 6 = 22 - 6 = 16$

but $x = 4$ → speed (1) = 4 → speed (2) $x - 6 = -2$ not possible **5m**

* Accept candidate's equation from **(c) (iii)**

Blunders (-3)

B1 Correct answer, no work shown ✍

B2 Sign error

B3 Distribution error

B4 Transposition error

B5 Mathematical error

B6 Correct factors and stops

B7 Incorrect factors

B8 Errors using quadratic formula

Slips (-1)

S1 Numerical errors to a max of -3

S2 Does not (or cannot) conclude that speed of – 2 is not possible

S3 Doesn't find speeds between Greystones and Bray for second part of the journey

Attempts (*2 marks*)

A1 Linear equation merits attempt at most

A2 Any correct relevant step

A3 Quadratic formula with some correct substitution

A4 Attempt at factorising

Worthless (0)

W1 Incorrect answer and no work shown

W2 ( ) ( )

W3 No work of merit

QUESTION 4

Part (a)	**10 marks**	**Att 3**
Part (b)	**20 marks**	**Att (2,2,3)**
Part (c)	**20 marks**	**Att (3,2,2)**

Part (a)	**10 marks**	**Att 3**

> ✍ Graph on the number line the solution set of
>
> $$4 - x \;\geq\; 2x - 5,\; x \in \mathbb{N}.$$

(a)	**10 marks**	**Att 3**

I

$4 - x \qquad 2x - 5$

$4 + 5 \qquad 2x + x$

$9 \qquad 3x$

$9 \;\; 3 \qquad x$

$3 \qquad x$ **7m**

II

$4 - x \qquad 2x - 5$

$-x - 2x \qquad -5 - 4$

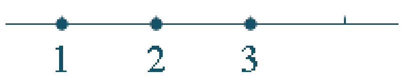
$-3x \qquad -9$

$3x \qquad 9$

$x \qquad 9 \div 3$

$x \qquad 3$ **7m**

$x \;\leq\; 3 \rightarrow \{1,2,3\}$ **7m**



10m

Blunders (-3)

B1 Correct answer no work shown ✍
B2 Transposition error
B3 Mishandles inequality
B4 $x \in$ R or x Z indicated
B5 Mathematical error
B6 No number line drawn
B7 Values outside of range graphed, note S2

Slips (-1)

S1 Numerical errors to a maximum of -3
S2 Includes 0

Misreadings (-1)

M1 Excludes equals in inequality

Attempts (3 marks)

A1 Tests any value in the inequality and stops
A2 Draws a number-line
A3 No inequality, solves equation to get $x = 3$
A4 Any relevant step

Worthless (0)

W1 List given with no correct value
W2 No work of merit

Part (b)	**20 (5,5,10) marks**	**Att (2,2,3)**

Electricity is charged to a consumer at a day rate and at a night rate.
Day rate units are charged at 14 cent per unit
and night rate units are charged at 7 cent per unit.
A consumer uses a total of 1100 units for a billing period, at a cost of €129·50.

(i) By letting x equal the number of day rate units used and y equal the number of night rate units used, write two equations to represent the above information.

(ii) ✍ Solve these equations to find the number of each type of unit used.

(b) (i)	**10 (5,5)marks**	**Att 2,2**

$x + y = 1100$ **5m**

$0{\cdot}14x + 0{\cdot}07y = 129{\cdot}50$ **or** $14x + 7y = 12950$ **5m**

* Two equations to mark in **(b)(i)**
* Each equation is marked separately
* Each equation is worth 5marks, attempt 2
* Equations sufficient, no ✍ in question

Blunders (-3)

B1 Incorrect term
B2 Decimal error

Attempts (2,2 marks)

A1 Mentions x or y or $14x$ or $7y$ or $\cdot 14x$ or $\cdot 07y$
A2 Effort at creating an equation equal to 1100 or 129·50 or 12950
A3 Any relevant step

(b) (ii) **10 marks** **Att 3**

I

$$\begin{aligned} x + y &= 1100 \; (-7) \\ \underline{14x + 7y} &\underline{= 12950} \\ -7x - 7y &= -7700 \\ \underline{14x + 7y} &\underline{= 12950} \\ 7x &= 5250 \\ x &= \frac{5250}{7} \\ x &= 750 \\ x + y &= 1100 \\ 750 + y &= 1100 \\ y &= 1100 - 750 \\ y &= 350 \end{aligned}$$

$$\begin{aligned} x + y &= 1100 \; (-14) \\ \underline{14x + 7y} &\underline{= 12950} \\ -14x - 14y &= -15400 \\ \underline{14x + 7y} &\underline{= 12950} \\ -7y &= -2450 \\ y &= \frac{-2450}{-7} \\ y &= 350 \\ x + y &= 1100 \\ x + 350 &= 1100 \\ x &= 1100 - 350 \\ x &= 750 \end{aligned}$$

$$\begin{aligned} x + y &= 1100 \; (-1) \\ \underline{14x + 7y} &\underline{= 12950} \; (\div 7) \\ -x - y &= -1100 \\ \underline{2x + y} &\underline{= 1850} \\ x &= 750 \\ x + y &= 1100 \\ 750 + y &= 1100 \\ y &= 1100 - 750 \\ y &= 350 \end{aligned}$$

$$\boldsymbol{x = 750 \quad y = 350}$$

II

$$\begin{aligned} x + y &= 1100 \\ y &= 1100 - x \\ 14x + 7(1100 - x) &= 12950 \\ 14x + 7700 - 7x &= 12950 \\ 7x &= 12950 - 7700 \\ 7x &= 5250 \\ x &= 750 \\ y &= 350 \end{aligned}$$

$$\begin{aligned} x + y &= 1100 \\ x &= 1100 - y \\ 14(1100 - y) + 7y &= 12950 \\ 15400 - 14y + 7y &= 12950 \\ -7y &= 12950 - 15400 \\ -7y &= -2450 \\ 7y &= 2450 \\ y &= 350 \\ x &= 750 \end{aligned}$$

*1 Accept candidate's answers from part **(i)** provided oversimplification does not occur
*2 Apply only one blunder deduction B1 or B2 to any errors in establishing the first equation
*3 Finding the second variable is subject to a maximum deduction of 3 marks
*4 Correct values of x and y without algebraic work, **both verified in both equations** merits full marks
*5 Correct values of x and y without algebraic **work not verified or not fully verified in both equations** merits attempt mark only
*6 Equations may also be solved by substituting $x = \frac{12950 - 7y}{14}$ or $y = \frac{12950 - 14x}{7}$

Blunders (-3)

B1 Error(s) in establishing the first equation in terms of x *i.e.* $(7x = 5250)$ through elimination by cancellation or elimination by substitution
B2 Error(s) in establishing the first equation in terms of y *i.e.* $(7y = 2450)$ through elimination by cancellation or elimination by substitution
B3 Distribution error
B4 Transposition error
B5 Mathematical error
B6 Fails to find second variable

Slips (-1)
S1 Numerical errors to a max of 3

Misreadings (-1)
M1 Misreads a digit provided it doesn't oversimplify, apply each time to a max of 3

Attempts (3 marks)
A1 Any correct manipulation of either equation and stops

Worthless (0)
W1 Incorrect answer, no work shown
W2 Trial and error, but note *4 and *5
W3 No work of merit

Part (c) **20 (10,5,5) marks** **Att (3,2,2)**

(i)	✍	Solve the equation $x^2 - 6x + 4 = 0$, giving your answer in the form of $a \pm \sqrt{b}$, where $a,\ b\ \in \mathbb{N}$.
(ii)	✍	Hence, or otherwise, find two values for p for which $(3 + p)^2 - 6(3 + p) + 4 = 0$.
(iii)	✍	Show that the sum of the two values of p is zero.

(c) (i) **10 marks** **Att 3**

I

$x^2 - 6x + 4 = 0$

$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

a = 1 b = − 6 c = 4

$\frac{-(-6) \pm \sqrt{(-6)^2 - 4(1)(4)}}{2(1)}$

$= \frac{6 \pm \sqrt{36 - 16}}{2}$

$= \frac{6 \pm \sqrt{20}}{2} = \frac{6 \pm 2\sqrt{5}}{2} = 3 \pm \sqrt{5}$

II

$x^2 - 6x + 4 = 0$

$x^2 - 6x + 9 - 5 = 0$

$(x - 3)^2 - (\sqrt{5})^2 = 0$

$(x - 3 - \sqrt{5})\ (x - 3 + \sqrt{5}) = 0$

$x - 3 - \sqrt{5} = 0$ or $x - 3 + \sqrt{5} = 0$

$x = 3 + \sqrt{5}$ or $x = 3 - \sqrt{5}$

B1 Correct answer no work shown ✍
B2 Error in quadratic formula once only
B3 Error in substitution once only
B4 Error when applying quadratic formula once only
B5 Invalid cancelling or stops at $\frac{6 \pm \sqrt{20}}{2}$ or similar
B6 Error in completing the square in method **II**
B7 Error in factors in method **II**
B8 Error in establishing roots or incorrect format for roots in method **II**

Slips (-1)
S1 Each numerical error to a max of -3

Attempts (3 marks)
A1 Identifies *a, b* or *c* correctly and stops
A2 Some attempt at factorising *e.g.* (x) (x)

Worthless (0)
W1 Incorrect answer without work
W2 No work of merit

(c) (ii) **5 marks** **Att 2**

I

$(3 + p)^2 - 6(3 + p) + 4 = 0$ Given

From **c (i)** $x = 3 + p$ **2m**

So $3 + p = 3 \pm \sqrt{5}$

$p = \pm\sqrt{5}$ **5m**

II

$(3 + p)^2 - 6(3 + p) + 4 = 0$ Given

$9 + 6p + p^2 - 18 - 6p + 4 = 0$ **2m**

$p^2 - 5 = 0$

$(p - \sqrt{5})(p + \sqrt{5}) = 0$

$p = \sqrt{5}$ and $p = -\sqrt{5}$ **5m**

*Accept candidate's answers from part **(c)(i)**

Blunders (-3)

B1 Correct answer no work shown ✍

B2 Sign error

B3 Transposition error

B4 Mathematical error

B5 Distribution error

B6 Finds one solution only

Slips (-1)

S1 Numerical errors to a max of -3

Attempts (2 marks)

A1 States $x = 3 + p$ and stops

A2 Some use of answer from part (i)

A3 Some correct multiplication in **II**

A4 Any relevant step

Worthless (0)

W1 Incorrect answer without work

W2 No work of merit

(c) (iii) **5 marks** **Att 2**

Sum of roots	$= \sqrt{5} + (-\sqrt{5})$
	$= 0$

* Accept candidate's answers from part **(c)(ii)** above
* If candidate's $p_1 + p_2 \neq 0$ and candidate acknowledges this with work, award full marks

Blunders (-3)

B1 States $\sqrt{5} - \sqrt{5} \neq 0$

B2 Incorrectly states that candidate's $p_1 + p_2 = 0$

B3 Decimal error

B4 Fails to finish

Slips (-1)

S1 Numerical errors to a max of -3

Attempts (2 marks)

A1 Some use of candidate's answers from part **(ii)**

A2 Some relevant step

Worthless (0)

W1 0 only or = 0 only

W2 No work of merit

QUESTION 5

Part (a)	**10 marks**	**Att 3**
Part (b)	**10 marks**	**Att (2,2)**
Part (c)	**30 marks**	**Att (3,3,2,2)**

Part (a)	**10 marks**	**Att 3**

✍ Given that $4d = \frac{2c}{3} + \frac{a}{5}$, write a in terms of c and d.

(a)	**10 marks**	**Att 3**

I

$4d = \frac{2c}{3} + \frac{a}{5}$	Given
$4d - \frac{2c}{3} = \frac{a}{5}$	**7m**
$5\left(4d - \frac{2c}{3}\right) = a$ *or* $a = \frac{60d - 10c}{3}$ *or* $a = 20d - \frac{10c}{3}$	**10m**

II

$4d = \frac{2c}{3} + \frac{a}{5}$	Given
$LCM = 15$	**3m**
$15(4d) = 15(\frac{2c}{3}) + 15(\frac{a}{5})$	**3m**
$60d = 10c + 3a$	**4m**
$60d - 10c = 3a$	**7m**
$a = \frac{60d - 10c}{3}$ *or* $a = 20d - \frac{10c}{3}$ *or* $a = 5\left(4d - \frac{2c}{3}\right)$	**10m**

* Other methods may be used

Blunders (-3)

B1 Correct answer no work shown ✍
B2 Mishandles numerator
B3 Incorrect LCM in **II** (any multiple of 15 acceptable)
B4 Transposition error
B5 Mathematical error
B6 Fails to finish

Slips (-1)

S1 Numerical errors to a max of -3

Misreadings (-1)

M1 Misreads a digit provided it doesn't oversimplify the question

Attempts (3 marks)

A1 Correct LCM only
A2 Any relevant step

Worthless (0)

W1 Incorrect answer, no work shown
W2 No work of merit

Part (b)	**10 (5,5)marks**	**Att (2,2)**

(i) ✍ Find the value of $3x^2 - 5x + \frac{4}{x}$, when $x = \frac{2}{3}$.

(ii) ✍ Solve the equation $\frac{x-1}{3} - \frac{5x+2}{4} = 1$.

(b) (i)	**5 marks**	**Att 2**

I

$3\left(\frac{2}{3}\right)^2 - 5\left(\frac{2}{3}\right) + \frac{4}{\left(\frac{2}{3}\right)} =$ **2m**

$\frac{4}{3} - \frac{10}{3} + \frac{12}{2}$

$\frac{-6}{3} + 6$

$-2 + 6$

4 **5m**

OR

II

$\frac{x(3x^2) - x(5x) + 4}{x}$

$\frac{3x^3 - 5x^2 + 4}{x}$

$\frac{3\left(\frac{2}{3}\right)^3 - 5\left(\frac{2}{3}\right)^2 + 4}{\frac{2}{3}}$ **2m**

$\frac{\frac{8}{9} - \frac{20}{9} + 4}{\frac{2}{3}}$

$\frac{\frac{-12}{9} + 4}{\frac{2}{3}}$

$\frac{\frac{-12}{9} + \frac{36}{9}}{\frac{2}{3}}$

$\frac{\frac{24}{9}}{\frac{2}{3}}$

$\frac{24}{9} \times \frac{3}{2}$

$= 4$ **5m**

Blunders (-3)

B1 Correct answer no work shown ✍

B2 Incorrect substitution *e.g.* $x = \cdot 6$, gives 4·74, but see S2

B3 Incorrect handling of fractions

B4 Drops denominator or mishandles denominator

B5 Mathematical error

B6 Mishandles numerator

B7 Distribution error

B8 Fails to finish

Slips (-1)

S1 Numerical errors to a max of -3

S2 If decimal is used and answer can be rounded to 4 correctly, but is not; otherwise B2

Misreadings (-1)

M1 Misreads a digit provided it doesn't oversimplify the question

Attempts (2 marks)

A1 Some correct substitution

A2 No denominator used **II**

A3 Any relevant step

Worthless (0)

W1 Incorrect answer, no work shown

W2 No work of merit

(b) (ii) **5 marks** **Att 2**

I

$$\frac{(x-1)}{3} - \frac{(5x+2)}{4} = 1 \qquad \text{Given}$$

$4(x-1) - 3(5x+2) = 12\ (1)$ **2m**

$4x - 4 - 15x - 6 = 12$

$-11x - 10 = 12$

$-11x = 12 + 10$

$-11x = 22$

$x = -2$ **5m**

II

$$\frac{4(x-1)}{12} - \frac{3(5x+2)}{12} = \frac{1}{1} \qquad \textbf{2m}$$

$$\frac{4x - 4 - 15x - 6}{12} = 1$$

$$\frac{-11x - 10}{12} = 1$$

$-11x - 10 = 12\ (1)$

$-11x = 12 + 10$

$-11x = 22$

$x = -2$ **5m**

* Other methods may be used

* $x = -2$ **verified** is worth 5 marks

Blunders (-3)

B1 Correct answer no work shown ✍

B2 Sign error

B3 Incorrect denominator

B4 Mishandles numerator

B5 Mathematical error

B6 Transposition errors

B7 Drops denominator or mishandles denominator

B8 Fails to finish

Slips (-1)

S1 Numerical error to a max of 3

Attempts (2 marks)

A1 Correct denominator only

A2 No denominator, oversimplified

A3 Some relevant step

Worthless (0)

W1 Incorrect answer no work shown

W2 No work of merit

Part (c)	**30 (10,10,5,5) marks**	**Att (3,3,2,2)**

Let f be the function $f : x \to 10 - x - 2x^2$.

(i) ✍ Draw the graph of f for $-3 \leq x \leq 3,\ x \in \mathbb{R}$.
(ii) Use your graph to estimate the maximum value of $f(x)$.
(iii) Use your graph to estimate the values of x for which $f(x) = 6$.

(c) (i) Function *f*	**20(10,10) marks**	**Att (3,3)**

I

x	-3	-2	-1	0	1	2	3
***f*(*x*)**	-5	4	9	10	7	0	-11

II

$f(x) = 10 - x - 2x^2$

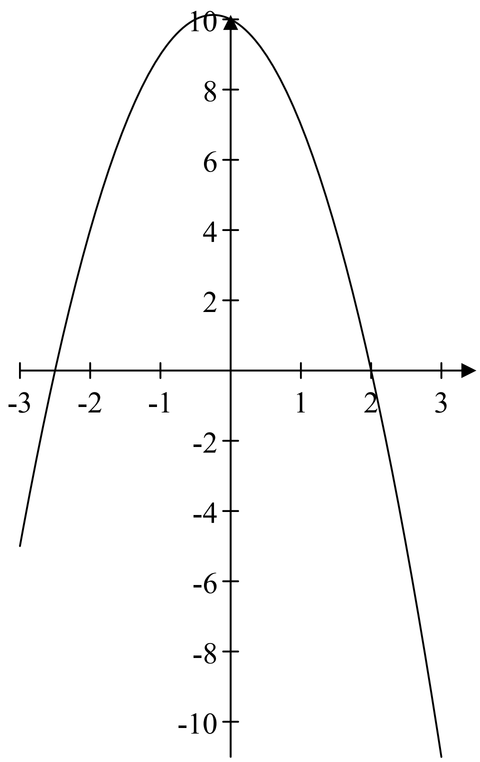
$f(-3) = 10 - (-3) - 2(-3)^2 = 10 + 3 - 2(9) = 10 + 3 - 18 = -5 \to (-3,-5)$
$f(-2) = 10 - (-2) - 2(-2)^2 = 10 + 2 - 2(4) = 10 + 2 - 8 = 4 \to (-2,4)$
$f(-1) = 10 - (-1) - 2(-1)^2 = 10 + 1 - 2(1) = 10 + 1 - 2 = 9 \to (-1,9)$
$f(0) = 10 - (0) - 2(0)^2 = 10 + 0 - 2(0) = 10 + 0 - 0 = 10 \to (0,10)$
$f(1) = 10 - (1) - 2(1)^2 = 10 - 1 - 2(1) = 10 - 1 - 2 = 7 \to (1,7)$
$f(2) = 10 - (2) - 2(2)^2 = 10 - 2 - 2(4) = 10 - 2 - 8 = 0 \to (2,0)$
$f(3) = 10 - (3) - 2(3)^2 = 10 - 3 - 2(9) = 10 - 3 - 18 = -11 \to (3,-11)$

III

x	-3	-2	-1	0	1	2	3	
10	10	10	10	10	10	10	10	
$-x$	3	2	1	0	-1	-2	-3	
$-2x^2$	-18	-8	-2	0	-2	-8	-18	
$f(x)$	-5	4	9	10	7	0	-11	
Points	$(-3,-5)$	$(-2,4)$	$(-1,9)$	$(0,10)$	$(1,7)$	$(2,0)$	$(3,-11)$	

* Table is worth 10 marks, graph is worth 10 marks
* Middle lines of table do not have to be shown
* Consistent error(s) in each row/column attract a maximum deduction of 3
* Points might not be listed, mark on position on graph
* Graph constitutes work in this question
* Candidates may choose not to use a table
* If graph is correct award 20 marks

Points	$(-3,-5)$	$(-2,4)$	$(-1,9)$	$(0,10)$	$(1,7)$	$(2,0)$	$(3,-11)$	



* Accept candidate's values from table when plotting graph.

Blunders (-3)
B1 Error in calculating $-2x^2$, once if consistent, note A2
B2 Error in calculating $-x$, once if consistent
B3 Adds in domain row when evaluating $f(x)$
B4 Each incorrect point without work
B5 Each point plotted incorrectly, once if consistent
B6 Each missing point
B7 Axes reversed
B8 Scale error, apply once
B9 Points not joined to form curve or joined in incorrect order, apply once
B10 Graph not extended to include full domain

Slips (-1)
S1 Numerical errors to a max of -3

Misreadings (-1)
M1 Incorrect digit provided it does not oversimplify the question

Attempts (3,3 marks)
A1 Draws axes with some indication of scaling
A2 Errors leading to a linear graph
A3 Some correct substitution
A4 Some relevant step

(c) (ii) **5 marks** **Att 2**

Max at $f(x)$ or $y = 10{\cdot}1$

* Accept answer consistent with candidate's graph
* Tolerance = $\pm\, 0{\cdot}2$ of candidate's graph

Blunders (-3))
B1 Maximum indicated on graph but no value stated
B2 States or indicates x co-ordinate of maximum point

Slips (-1)
S1 Writes maximum point instead of maximum value

Attempts (2 marks)
A1 Some relevant work

(c) (iii) **5 marks** **Att 2**

$f(x) = 6 \quad \rightarrow \quad x = 1{\cdot}2$ or $-1{\cdot}7$.

* Accept answer consistent with candidate's graph
* Tolerance = $\pm\, 0{\cdot}2$ of candidate's graph

Blunders (-3)
B1 One value only if two available, see *1

Misreadings (-1)
M1 Misreads a digit providing it does not oversimplify the question
M2 Solves $f(x) = -6$

Attempts (2 marks)
A1 Some indication on graph at $y = 6$
A2 States $y = 6$

Worthless (0)
W1 Incorrect answer(s), no work shown
W2 No work of merit

QUESTION 6

Part (a)	**10 marks**	**Att 3**
Part (b)	**20 marks**	**Att (2,2,2,2)**
Part (c)	**20 marks**	**Att (3,2,2)**

Part (a) **10 marks** **Att 3**

Let g be the function $g : x \to 2^{x-3}$.

✍ Find the value of g (3).

(a) **10 marks** **Att 3**

I

$g(3) = 2^{3-3}$ **4m**

$= 2^0$ **7m**

$= 1$ **10m**

II

$g : x \to 2^{x-3}$

$= \dfrac{2^x}{2^3}$ **3m**

$= \dfrac{2^3}{2^3}$ **4m**

$= \dfrac{8}{8}$ **7m**

$= 1$ **10m**

Blunders (-3)

B1 Correct answer no work shown ✍
B2 Mishandles 2^0
B3 Mishandles indices, once if consistent
B4 $2^{3-3} = 2^3 - 2^3$ and continues correctly
B5 Fails to finish *e.g.* stops at 2^0

Attempts (3 marks)

A1 $x = 3$ and stops
A2 8

Worthless (0)

W1 Incorrect answer no work shown, note A2
W2 $2 \times 3 = 6$
W3 No work of merit

Part (b)	20 (5,5,5,5) marks	Att (2,2,2,2)

Let f be the function $f : x \to x^2 - 3x$.

(i) ✍ Express $f(t)$ and $f(2t + 1)$ in terms of t.

(ii) ✍ Hence, find the values of t for which $f(t) = f(2t + 1)$.

(b)(i)	10(5,5) marks	Att (2,2)

$f : x \to x^2 - 3x$	Given		
$f(t)$	$=$	$t^2 - 3t$	**5m**
$f(2t + 1)$	$=$	$(2t + 1)^2 - 3(2t + 1)$	**5m**

* 2 parts to mark $f(t)$ **and** $f(2t + 1)$ **5m** each

* Accept $t^2 - 3t$ for 5 marks

* Accept $(2t + 1)^2 - 3(2t + 1)$ for 5 marks

* Ignore notation if consistent

Blunders (-3)

B1 Substitution error

B2 $(2t + 1)^2 + 3(2t + 1)$

Misreadings (-1)

M1 Misreads a digit providing it does not oversimplify the question

Attempts (2,2 marks)

A1 Some correct substitution

A2 States $x = t$

A3 States $x = 2t + 1$

A4 Any relevant step

Worthless (0)

W1 No work of merit

(b) (ii) **(5,5) marks** **Att (2,2)**

$t^2 - 3t = 4t^2 + 4t + 1 - 6t - 3$ **2m**

$t^2 - 3t = 4t^2 - 2t - 2$

$4t^2 - 2t - 2 - (t^2 - 3t) = 0$

$4t^2 - 2t - 2 - t^2 + 3t = 0$

$3t^2 + t - 2 = 0$ **5m**

and

I

$(t + 1)(3t - 2) = 0$

$\rightarrow \quad t = -1,\ t = \frac{2}{3}$ **5m**

or

II

$3t^2 + t - 2 = 0$

$3t^2 + 3t - 2t - 2 = 0$

$3t(t + 1) - 2(t + 1) = 0$

$(t + 1)(3t - 2) = 0$

$\rightarrow \quad t = -1,\ t = \frac{2}{3}$ **5m**

or

III

$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ $a = 3,\ b = 1,\ c = -2$

$x = \frac{-1 \pm \sqrt{1^2 - 4(3)(-2)}}{2(3)}$

$x = \frac{-1 \pm \sqrt{1^2 - (-24)}}{6}$

$x = \frac{-1 \pm \sqrt{25}}{6}$

$x = \frac{-1 \pm 5}{6}$

$x = \frac{-6}{6}$

$x = \frac{4}{6}$

$\rightarrow \quad t = -1,\ t = \frac{2}{3}$ **5m**

* Mark in 2 parts, **5m** for establishing an equation and **5m** for solving

* Accept candidate's answers from **(b)(i),** but note A1

Blunders (-3)

B1 Correct answer no work shown ✍

B2 Sign error

B3 Transposition error

B4 Squaring error

B5 Mathematical error

B6 Substitution error

B7 Error in quadratic formula

B8 Distribution error

B9 $(2t^2 + 1) + 3(2t + 1)$ and continues correctly, if not already penalised in **(b)(i)**

B10 Error in solving

B11 Finds one solution only

B12 Fails to finish

Slips (-1)

S1 Numerical error to a max of -3

Misreadings (-1)

M1 Misreads a digit providing it does not oversimplify the question

Attempts (2,2 marks)

A1 Linear equation merits *Att* 2, *Att* 2 at most

A2 Attempt to form equation

A3 Attempt to solve

A4 Some use of answer(s) from **(b)(i)**

A5 Any relevant step

Worthless (0)

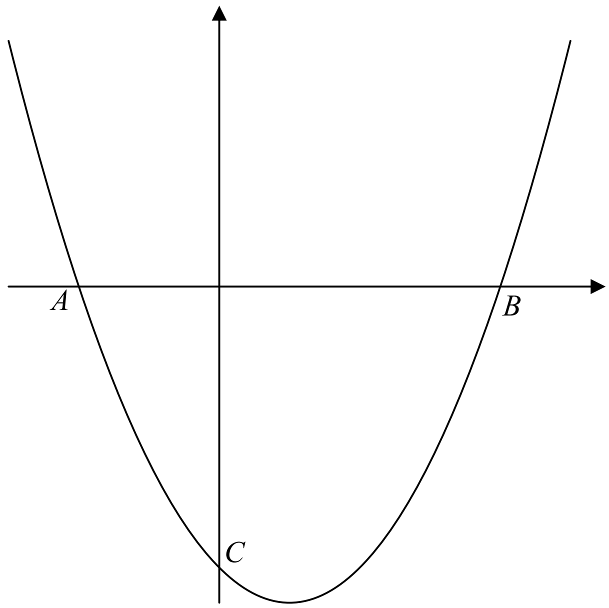
W1 Incorrect answer(s), no work shown

W2 $t = 2t + 1$ and stops

W3 No work of merit

Part (c) **20 (10,5,5) marks** **Att (3,2,2)**

The diagram below shows part of the graphs of the function $f : x \to x^2 - 2x - 8,\ x \in \mathbb{R}$.



(i) The graph intersects the x axis at A and B and the y axis at C.

✍ Find the co-ordinates of A, B and C.

(ii) Hence, write down the range of values of x for which $x^2 - 2x - 8 \leq 0$.

(c) (i) **15(10,5) marks** **Att (3,2)**

<u>Intersects x axis</u>:

I

$x^2 - 2x - 8 = 0$	**3m**
$(x - 4)(x + 2) = 0$	**7m**
$x = 4, x = -2$	**9m**
→ $A(-2, 0)$ $B(4, 0)$	**10m**

II

$x^2 - 2x - 8 = 0$	**3m**
$x^2 - 4x + 2x - 8 = 0$	**3m**
$x(x - 4) + 2(x - 4) = 0$	**4m**
$(x - 4)(x + 2) = 0$	**7m**
$x = 4, x = -2$	**9m**
→ $A(-2, 0)$ $B(4, 0)$	**10m**

III

$x^2 - 2x - 8 = 0$ **3m**

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$x = \frac{+2 \pm \sqrt{4 - 4(1)(-8)}}{2}$$ **3m**

$$x = \frac{+2 \pm \sqrt{4 + 32}}{2}$$ **4m**

$$x = \frac{+2 \pm 6}{2}$$ **7m**

$x = 4, x = -2$ **9m**

→ $A(-2, 0)$ $B(4, 0)$ **10m**

Intersects y axis:

$f(0) = (0)^2 - 2(0) - 8$ **2m**

$f(0) = -8$ **4m**

→ $C(0, -8)$ **5m**

* Mark in two separate parts. **10m** for finding where graph intersects x axis, **5m** for where graph intersects y axis

* Correct answer fully verified is full marks

Blunders (-3)

B1 Correct answer no work shown ✍

B2 Sign error

B3 Incorrect operation

B4 Incorrect factors

B5 Mathematical error

B6 Error in quadratic

B7 Error in substitution

B8 Transposition error

B9 Square root error

B10 Finds one solution only (*i.e.* $x = 4$ **or** $x = -2$)

Slips (-1)

S1 Does not write co-ordinate

S2 Does not label A or B, or labels them incorrectly. Apply once.

Misreadings (-1)

M1 Misreads a digit providing it does not oversimplify the question

Attempts (3,2 marks)

A1 Effort to solve equation (= 0) or any indication of $y = 0$

A2 Effort to substitute ($x = 0$)

A3 Quadratic with some correct substitution

A4 $x = 4$ and/or $x = -2$ only with no work

A5 Some relevant step

Worthless (0)

W1 Incorrect answer(s), no work shown

W2 No work of merit

(c) (ii) **5 marks** **Att 2**

Range	$-2 \leq x \leq 4$

* Accept candidate's x values from **(c)(i)**
* Accept "from − 2 to 4 inclusive" or similar for full marks

Blunders (-3)
B1 Reversed inequalities
B2 $2 \leq x \leq 4$, minus sign omitted

Slips (-1)
S1 Does not include equals in inequalities

Attempts (2 marks)
A1 Some identification on graph
A2 $f(x) \leq 0$
A3 Some relevant step

Worthless (0)
W1 Incorrect answer(s) with no work of merit
W2 No work of merit

JUNIOR CERTIFICATE EXAMINATION

2012

MARKING SCHEME

MATHEMATICS
HIGHER LEVEL
PAPER 2

MARKING SCHEME
JUNIOR CERTIFICATE EXAMINATION 2012
MATHEMATICS - HIGHER LEVEL - PAPER 2

GENERAL GUIDELINES FOR EXAMINERS

1. Penalties of three types are applied to candidates' work as follows:
   - Blunders - mathematical errors/omissions (-3)
   - Slips- numerical errors (-1)
   - Misreadings (provided task is not oversimplified) (-1).

   Frequently occurring errors to which these penalties must be applied are listed in the scheme. They are labelled: B1, B2, B3,…, S1, S2,…, M1, M2,…etc. These lists are not exhaustive.

2. When awarding attempt marks, e.g. Att(3), note that
   - any *correct, relevant* step in a part of a question merits at least the attempt mark for that part
   - if deductions result in a mark which is lower than the attempt mark, then the attempt mark must be awarded
   - a mark between zero and the attempt mark is never awarded.

3. Worthless work is awarded zero marks. Some examples of such work are listed in the scheme and they are labelled as W1, W2,…etc.

4. The phrase "hit or miss" means that partial marks are not awarded – the candidate receives all of the relevant marks or none.

5. The phrase "and stops" means that no more work is shown by the candidate.

6. Special notes relating to the marking of a particular part of a question are indicated by an asterisk. These notes immediately follow the box containing the relevant solution.

7. The sample solutions for each question are not intended to be exhaustive lists – there may be other correct solutions.

8. Unless otherwise indicated in the scheme, accept the best of two or more attempts – even when attempts have been cancelled.

9. The *same* error in the *same* section of a question is penalised *once* only.

10. Particular cases, verifications and answers derived from diagrams (unless requested) qualify for attempt marks at most.

11. A serious blunder, omission or misreading results in the attempt mark at most.

12. Do not penalise the use of a comma for a decimal point, e.g. €5.50 may be written as €5,50.

BONUS MARKS FOR ANSWERING THROUGH IRISH

Bonus marks are applied separately to each paper as follows:

If the mark achieved is 225 or less, the bonus is 5% of the mark obtained, rounded **down**.
(e.g. 198 marks × 5% = 9.9 ⇒ bonus = 9 marks.)

If the mark awarded is above 225, the following table applies:

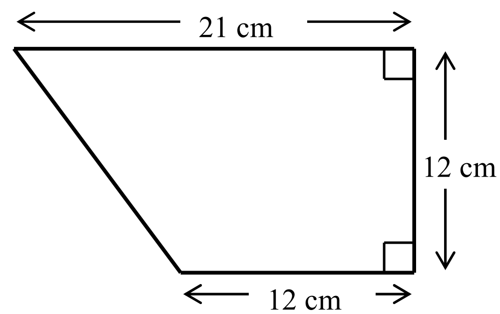
Bunmharc (Marks obtained)	Marc Bónais (Bonus Mark)	Bunmharc (Marks obtained)	Marc Bónais (Bonus Mark)
226	11	261 – 266	5
227 – 233	10	267 – 273	4
234 – 240	9	274 – 280	3
241 – 246	8	281 – 286	2
247 – 253	7	287 – 293	1
254 – 260	6	294 – 300	0

QUESTION 1

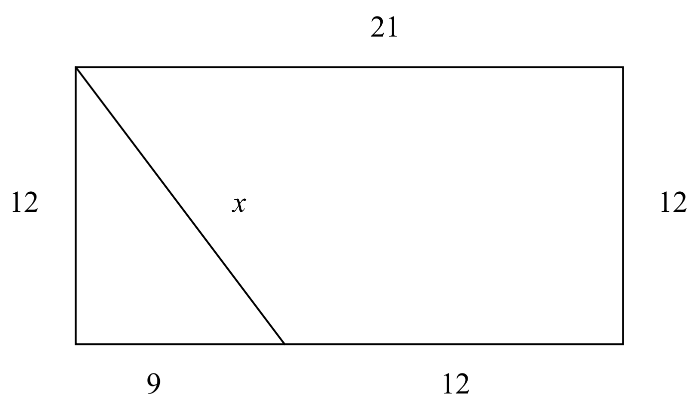
Part (a)	**10 marks**	**Att 3**
Part (b)	**20 (10,10) marks**	**Att (3,3)**
Part (c)	**20 (5,10,5) marks**	**Att (2,3,2)**

Part (a)	**10 marks**	**Att 3**

✍ Find the perimeter of the shape shown in the diagram.



(a)	**10 marks**	**Att 3**



9 found — Step 1

$$x^2 = 12^2 + 9^2$$
$$= 144 + 81$$
$$= 225$$
$$\Rightarrow x = 15$$ Step 2

Perimeter = 21 + 12 + 12 + 15 = 60cm — Step 3

Blunders (-3)

B1 Correct answer without work shown (✍)
B2 Error in Pythagoras' Theorem
B3 Error in squaring
B4 Each side omitted, having found x

Slips (-1)

S1 Arithmetic slips to a maximum of *(-3)*

Attempts (3 marks)

A1 Correct formula
A2 Two or more correct sides added
A3 Effort at Pythagoras' Theorem

Worthless (0)

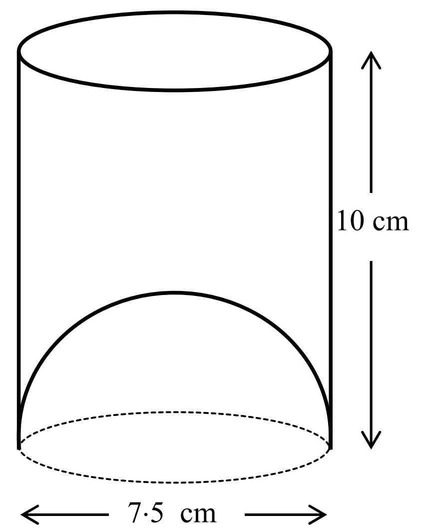
W1 Area formula

Part (b) **20 (10,10) marks** **Att (3,3)**

A drinking glass is in the shape of a cylinder of diameter 7·5 cm and of height 10 cm.
It has a hemispherical base as shown in the diagram.

(i) ✍ Calculate the curved surface area of the cylindrical part of the glass, correct to two decimal places.

(ii) ✍ Calculate the total surface area of the glass correct to two decimal places.



(b) (i) **10 marks** **Att 3**

Curved surface area $= 2\pi rh = 2 \times \pi \times 3{\cdot}75 \times 10$
$= 75\pi = 235{\cdot}619$
$= 235{\cdot}62 \text{ cm}^2$

* Value of π used, other than the value of π from the calculator, giving an answer in the range 235·50 - 235·71 incurs −1

Blunders (-3)

B1 Correct answer without work shown (✍)
B2 Incorrect relevant formula
B3 Incorrect substitution into correct formula
B4 Incorrect *r*
B5 Incorrect *h*
B6 Answer in terms of π
B7 Value of π which affects the accuracy of the answer, other than * above

Slips (-1)
S1 Arithmetic slips to a maximum of *(-3)*
S2 Answer not rounded or incorrectly rounded

Misreadings (-1)
M1 Curved surface area of hemisphere

Attempts (3 marks)
A1 $r = 3{\cdot}75$
A2 Indication that radius length is half of diameter length
A3 Correct formula with some correct substitution

Worthless (0)
W1 Volume formula for a cylinder

(b) (ii) **10 marks** **Att 3**

Surface area of hemisphere $= 2\pi r^2 = 2 \times \pi \times 3{\cdot}75^2$

$= 28{\cdot}125\pi$

$= 88{\cdot}357$ or $88{\cdot}36$ cm^2

Total surface area $= 75\pi + 28{\cdot}125\pi$ or $235{\cdot}62 + 88{\cdot}36$

$= 103{\cdot}125\pi$ or $323{\cdot}98$

$= 323{\cdot}9767$ or $323{\cdot}98$

$= 323{\cdot}98$cm^2

* Accept candidate's answer from (b) (i)

* Value of π used, other than the value of π from the calculator, giving an answer in the range 323·81 - 324·11 incurs −1, if not applied in (b) (i)

Blunders (-3)

B1 Correct answer without work shown (✍)
B2 Incorrect relevant formula
B3 Incorrect substitution into correct formula
B4 Incorrect r if different from (b) (i)
B5 Answer in terms of π, if not penalised in (b) (i)
B6 Value of π which affects the accuracy of the answer, if different from (b) (i)
B7 Error in squaring

Slips (-1)
S1 Arithmetic slips to a maximum of *(-3)*
S2 Answer not rounded or incorrectly rounded
S3 Failure to add areas
S4 Areas subtracted

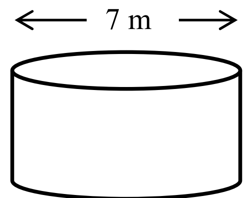
Attempts (3 marks)
A1 $r = 3{\cdot}75$
A2 Indication that radius length is half of diameter length
A3 Correct formula

Worthless (0)
W1 Volume formula for a hemisphere

Part (c) **20 (5,10,5) marks** **Att (2,3,2)**

A large building has a flat roof of length 50 m and of width 40 m.
On average there are 5 mm of rainfall on the roof in a week.

(i) ✍ Calculate the average volume of rain that will fall on the roof in a week. Give your answer in m^3.



The rain is harvested in a cylindrical tank of diameter 7 m.

(ii) ✍ Calculate the average rise in the level of the water in the tank in a week.
Give your answer in metres correct to two decimal places.

The tank is emptied when the water reaches a height of 3·38 m.

(iii) ✍ How many times a year, on average, will the tank be emptied?

(c) (i) **5 marks** **Att 2**

Volume of rain $= l \times b \times h$
$= 50 \times 40 \times 0{\cdot}005 \text{ m}^3$
$= 10 \text{ m}^3$

Blunders (-3)

B1 Correct answer without work shown (✍)
B2 Incorrect substitution into correct formula
B3 Answer not in m^3
B4 5 mm $\neq$ 0·005 m

Slips (-1)
S1 Arithmetic slips to a maximum of *(-3)*

Attempts (2 marks)
A1 Correct formula
A2 Indication of unit conversion
A3 50×40

(c) (ii) **10 marks** **Att 3**

$$\pi r^2 h = 10$$
$$\Rightarrow \pi \times (3{\cdot}5)^2 \times h = 10$$
$$\Rightarrow 12{\cdot}25\pi h = 10$$
$$\Rightarrow h = \frac{10}{12\cdot 25\pi} \quad \text{or} \quad \frac{10}{38\cdot 4845}$$
$$= 0\cdot 2598$$
$$= 0{\cdot}26 \text{ m}^2$$

* Accept candidate's answer from (c) (i)

Blunders (-3)

B1 Correct answer without work shown (✍)
B2 Incorrect relevant formula
B3 Incorrect substitution into correct formula
B4 Answer in terms of π
B5 Incorrect r
B6 Value of π which affects the accuracy of the answer
B7 Error in squaring

Slips (-1)
S1 Arithmetic slips to a maximum of *(-3)*
S2 Answer not rounded or incorrectly rounded

Attempts (3 marks)
A1 Correct formula with some correct substitution
A2 $r = 3{\cdot}5$
A3 Answer from (c) (i) mentioned

Worthless (0)
W1 Surface area formula for a cylinder

(c) (iii) **5 marks** **Att 2**

Number of weeks = $\dfrac{3\cdot 38}{0\cdot 26}$

$=13$

Number of times = $\dfrac{52}{13}$

$= 4$

OR

$0\cdot 26 \times 52 = 13\cdot 52$

Number of times = $\dfrac{13\cdot 52}{3\cdot 38}$

$= 4$

OR

Tank is emptied when Volume = $\pi r^2 h = \pi \times 3{\cdot}5^2 \times 3{\cdot}38$

$= 41{\cdot}405\pi$ or $130{\cdot}0776$

Number of weeks = $\dfrac{41\cdot 405\pi}{10}$ or $\dfrac{130\cdot 0776}{10}$

$= 13$

Number of times = $\dfrac{52}{13}$

$= 4$

* Accept candidate's answers from (c) (i) and (ii)

Blunders (-3)

B1 Correct answer without work shown (✍)
B2 Number of times per year not calculated
B3 Incorrect *r*, if not penalised in (c) (ii)
B4 Incorrect *h*
B5 Value of π which affects the accuracy of the answer, if not penalised in (c) (ii)

Slips (-1)

S1 Arithmetic slips to a maximum of *(-3)*

Attempts (2 marks)

A1 Correct formula with some correct substitution
A2 $r = 3{\cdot}5$
A3 Multiplication or division with 3·38
A4 Some use of answer in (c) (ii)

QUESTION 2

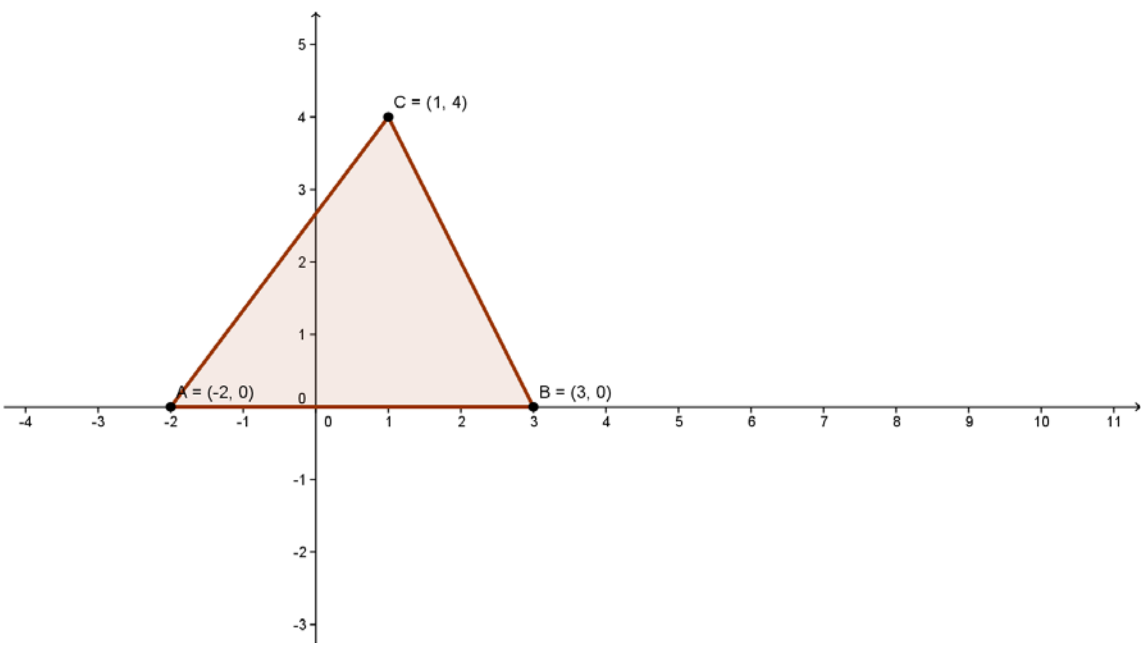
Part (a)	**25 marks**	**Att (5,3)**
Part (b)	**15 marks**	**Att (3,2)**
Part (c)	**10 marks**	**Att (2,2)**

Part (a)	**25 (15,10) marks**	**(5,3)**

(i) ✍ Using graph paper, draw the triangle with vertices $A\,(-2, 0)$, $B\,(3, 0)$ and $C\,(1, 4)$.

(ii) ✍ Calculate the area of the triangle ABC.

(a) (i)	**15 marks**	**Att 5**



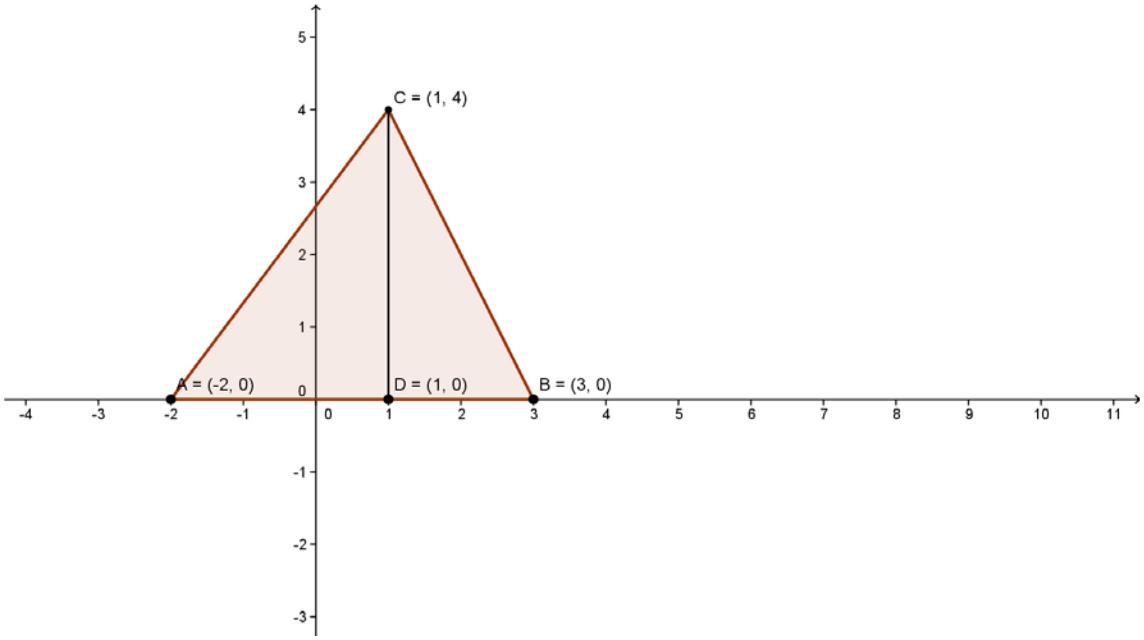
Blunders (-3)
B1 Scale not uniform
B2 Triangle not drawn
B3 Each incorrect point
B4 Both x and y coordinates switched

Slips (-1)
S1 Not drawn on graph paper

Attempts (5 marks)
A1 Scaled axes drawn
A2 One point plotted

Worthless (0)
W1 Unscaled axes drawn

(a) (ii) **10 marks** **Att 3**



$$\text{Area } \Delta ABC = \frac{1}{2}(\text{base})(\text{perpendicular height})$$

$$= \frac{1}{2}|AB|.|CD|$$

$$= \frac{1}{2}(5)(4)$$

$$= 10 \text{ units}^2$$

OR

$$| AC |=\sqrt{(1+2)^2+(4-0)^2}=\sqrt{3^2+4^2}=\sqrt{25}=5$$

$$|CD|=4$$

$$\sin\angle CAB=\frac{|CD|}{|AC|}=\frac{4}{5}$$

$$\text{Area } \Delta ABC=\frac{1}{2}| AC |.| AB |.\sin\angle CAB$$

$$=\frac{1}{2}(5)(5)\left(\frac{4}{5}\right)$$

$$=10 \text{ units}^2$$

OR

$$(-2,0)\to(0,0)$$

$$(1,4)\to(3,4)=(x_1,y_1)$$

$$(3,0)\to(5,0)=(x_2,y_2)$$

$$\text{Area}\Delta ABC=\frac{1}{2}|x_1y_2-x_2y_1|$$

$$=\frac{1}{2}|(3)(0)-(5)(4)|$$

$$=\frac{1}{2}|-20|=10 \text{ units}^2$$

OR

$$| BC |=\sqrt{(3-1)^2+(0-4)^2}=\sqrt{(2)^2+(-4)^2}=\sqrt{4+16}=\sqrt{20}$$

The sides are 5,5 and $\sqrt{20}$ in length

$$a=5,\ b=5,\ c=\sqrt{20}$$

$$s=\frac{5+5+\sqrt{20}}{2}=7\cdot 236$$

$$\text{Area}\Delta ABC=\sqrt{s(s-a)(s-b)(s-c)}=\sqrt{7\cdot 236(2\cdot 236)(2\cdot 236)(2\cdot 764)}$$

$$=\sqrt{99\cdot 995}$$

$$=10 \text{ units}^2$$

* Accept values consistent with candidate's graph

Blunders (-3)

B1 Correct answer without work shown (✍)
B2 Incorrect relevant formula
B3 Incorrect base
B4 Incorrect height
B5 Triangle taken to be right angled at the point (1,4)
B6 Incorrect sin ratio
B7 Error in squaring
B8 Error in translation

Slips (-1)
S1 Arithmetic slips to a maximum of *(-3)*

Attempts (3 marks)

A1 $\frac{1}{2}|x_1 y_2 - x_2 y_1|$ with some substitution
A2 Correct base or height

Worthless (0)
W1 Non - area formula with or without substitution

Part (b)	**15 (10,5) marks**	**Att (3,2)**

l is the line $2x - 11y = -16$ and k is the line $x + 2y = -8$.

(i) ✍ Find P, the point of intersection of l and k.

Q (3, 2) is on the line l and R (2, – 5) is on the line k.

(ii) ✍ Prove that the triangle PQR is isosceles.

(b) (i)	**10 marks**	**Att 3**

$l: 2x - 11y = -16$
$k: x + 2y = -8$

$l: 2x - 11y = -16$
$-2k: -2x - 4y = 16$
$\Rightarrow -15y = 0$
$\Rightarrow y = 0$
$\Rightarrow x = -8$

OR

$k: x + 2y = -8$
$\Rightarrow x = -8 - 2y$
$l: 2(-8 - 2y) - 11y = -16$
$\Rightarrow -16 - 15y = -16$
$\Rightarrow -15y = 0$
$\Rightarrow y = 0$
$\Rightarrow x = -8$

P is the point (–8, 0).

* Accept (–8, 0) $\in l$ and (–8, 0) $\in k$ shown in each case
* Accept $x = -8$ and $y = 0$ for full marks

Blunders (-3)
B1 Correct answer without work shown (✍)
B2 Transposition error
B3 Second value not found

Slips (-1)
S1 Arithmetic slips to a maximum of *(-3)*

Misreadings (-1)
M1 One value found and incorrectly substituted

Attempts (3 marks)
A1 Graphical solution correct

Worthless (0)
W1 Graphical solution incorrect

(b) (ii) **5 marks** **Att 2**

$$|PQ| = \sqrt{(-8-3)^2 + (0-2)^2}$$
$$= \sqrt{121+4}$$
$$= \sqrt{125}$$

$$|QR| = \sqrt{(2-3)^2 + (-5-2)^2}$$
$$= \sqrt{1+49}$$
$$= \sqrt{50}$$

$$|PR| = \sqrt{(-8-2)^2 + (0+5)^2}$$
$$= \sqrt{100+25}$$
$$= \sqrt{125}$$

$|PQ| = |PR|$

Therefore the triangle PQR is isosceles

* Accept candidate's answer from (b) (i)

Blunders (-3)

B1 Correct lengths without work shown (✍)
B2 Incorrect relevant formula
B3 Both x and y switched in substitution
B4 Error in squaring
B5 Error in signs

Slips (-1)

S1 Arithmetic slips to a maximum of *(-3)*
S2 One incorrect substitution for x or y
S3 No conclusion or incorrect conclusion

Misreadings (-1)

M1 x and y switched from (b) (i)

Attempts (2 marks)

A1 Correct formula with some correct substitution
A2 Attempt at $|PQ|$ or $|PR|$ or $|QR|$
A3 Indication of some knowledge of an isosceles triangle
A4 Attempt at difference of x values and/or difference of y values
A5 Triangle correctly plotted

Worthless (0)

W1 Incorrect formula with or without substitution

Part (c) **10 (5,5) marks** **Att (2,2)**

S is the point $(-4, -2)$ and T is the point $(2, 6)$.

(i) ✍ Find the equation of the perpendicular bisector of $[ST]$.

(ii) ✍ Verify that $(-5, 5)$ is a point on the perpendicular bisector.

(iii) ✍ Find the coordinates of the image of $(-5, 5)$ under the axial symmetry in ST.

(c) (i) **5 marks** **Att 2**

$$\text{Midpoint } [ST] = \left(\frac{-4+2}{2}, \frac{-2+6}{2}\right)$$

$$= (-1, 2)$$

$$\text{Slope } ST = \frac{6-(-2)}{2-(-4)} = \frac{8}{6} \text{ or } \frac{4}{3}$$ Step 1

$$\text{Slope of the perpendicular bisector} = -\frac{6}{8} \text{ or } -\frac{3}{4}$$ Step 2

Equation of perpendicular bisector: $y - 2 = -\frac{6}{8}(x+1)$ or $y - 2 = -\frac{3}{4}(x+1)$ Step 3

$$8y - 16 = -6x - 6 \qquad \text{or} \qquad 4y - 8 = -3x - 3$$

$$6x + 8y - 10 = 0 \qquad\qquad 3x + 4y - 5 = 0$$

Blunders (-3)

B1 Correct answer without work shown (✍)
B2 Incorrect relevant formula
B3 Both x and y switched in substitution
B4 Midpoint not found or found graphically
B5 Incorrect slope for perpendicular bisector

Slips (-1)

S1 Arithmetic slips to a maximum of *(-3)*
S2 One incorrect substitution for x or y

Attempts (2 marks)

A1 Correct formula with some correct substitution
A2 Attempt at difference of x values and/or difference of y values
A3 Indication that the product of the slopes of perpendicular lines is -1
A4 Midpoint or slope found
A5 Graphical solution for slope correct
A6 Indication of some knowledge of perpendicular bisector

Worthless (0)

W1 Incorrect formula with or without substitution

(c) (ii) & (iii) **5 marks** **Att 2**

$(-5, 5) : y - 2 = -\frac{3}{4}(x+1)$	**OR**	$(-5, 5) : 3x + 4y - 5 = 0$
$5 - 2 = -\frac{3}{4}(-5 + 1)$		$3(-5) + 4(5) - 5 = 0$
$3 = -\frac{3}{4}(-4)$		$-15 + 20 - 5 = 0$
$3 = 3$		$0 = 0$

* Accept candidates answer from (c) (i)

* Errors in simplifying equation in (c) (i) to a maximum of *(-3)*

Blunders (-3)

B1 Transposition error

B2 Both x and y switched in substitution

Slips (-1)

S1 Arithmetic slips to a maximum of *(-3)*

S2 Incorrect conclusion

Attempts (2 marks)

A1 Graphical solution correct

Worthless (0)

W1 Graphical solution incorrect

(c) (iii)

$(-5, 5)$ is on the perpendicular bisector

$\therefore$ The image of $(-5,5)$ under axial symmetry in ST is the same as central symmetry in $(-1,2)$

$$(-5, 5) \rightarrow (-1, 2) \rightarrow (3,-1)$$

Answer $(3,-1)$

Blunders (-3)

B1 Correct answer without work shown (✍)

B2 Wrong translation

B3 One coordinate of image point only

Slips (-1)

S1 Arithmetic slips to a maximum of *(-3)*

Attempts (2 marks)

A1 Some correct work with a translation

Worthless (0)

W1 The two given points plotted

QUESTION 3

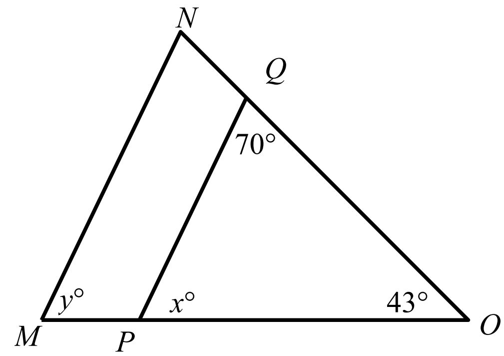
Part (a)	**20 marks**	**Att (5,2)**
Part (b)	**20 marks**	**Att (5,2)**
Part (c)	**10 marks**	**Att (2,2)**

Part (a) **20 (15,5) marks** **Att (5,2)**

In the diagram $[MN]$ is parallel to $[PQ]$.
$|\angle POQ| = 43°$ and $|\angle OQP| = 70°$.
Find

(i) ✍ the value of x

(ii) the value of y.



(a) (i) **15 marks** **Att 5**

$x = 180 - (70 + 43)$
$= 180 - 113$
$= 67$

* Accept work on diagram

Blunders (-3)

B1 Correct answer without work shown (✍)
B2 Sum of angles in a triangle $\neq 180^o$

Slips (-1)

S1 Arithmetic slips to a maximum of *(-3)*

Attempts (5 marks)

A1 Indication that the sum of the angles in a triangle = 180^o
A2 Indication that a straight angle = 180^o
A3 Indication of 113

Worthless (0)

W1 Diagram from examination paper either partially or fully drawn

(a) (ii) **5 marks** **Att 2**

$y = 67$

* Accept candidate's answer from (a) (i)
* Accept work on diagram

Blunders (-3)

B1 Sum of angles in a triangle $\neq 180^o$
B2 Sum of angles in a quadrilateral $\neq 360^o$

Attempts (2 marks)

A1 Mention of corresponding angles
A2 Indication of 110 and/or 113
A3 Indication that the sum of the angles in a triangle = 180^o
A4 Indication that the sum of the angles in a quadrilateral = 360^o

Worthless (0)

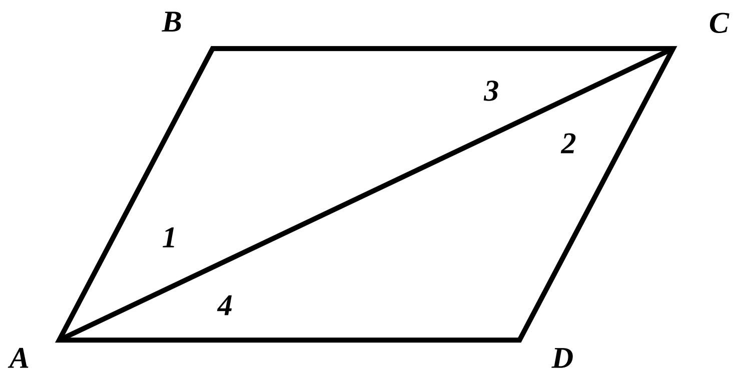
W1 Diagram from examination paper either partially or fully drawn
W2 $y = 70$ or 43

Part (b)	20 (15,5) marks	Att (5,2)

(i) ✍ Prove that opposite sides and opposite angles of a parallelogram are respectively equal in measure.

(ii) ✍ Show how to divide a line segment into three equal parts.
All construction lines must be clearly shown.

(b) (i)	15 marks	Att 5



Given: Parallelogram $ABCD$

To Prove: $|AB| = |DC|$ and $|BC| = |AD|$
$|\angle ABC| = |\angle ADC|$ and $(|\angle BAD| = |\angle BCD|)$ Step 1

Construction: Join A to C Step 2
Label angles 1, 2, 3 and 4

Proof: $|\angle 1| = |\angle 2|$................... alternate angles
$|\angle 3| = |\angle 4|$................... alternate angles
$|AC| = |AC|$....................... common side Step 3
$\therefore \ \Delta ABC \equiv \Delta ADC$................ A.S.A. Step 4
$\Rightarrow \ |AB| = |DC|$ and $|BC| = |AD|$..(corresponding sides)
and $|\angle ABC| = |\angle ADC|$............(corresponding angles)

Also, $|\angle 1| + |\angle 4| = |\angle 2| + |\angle 3|$
$\Rightarrow |\angle BAD| = |\angle BCD|$ Step 5

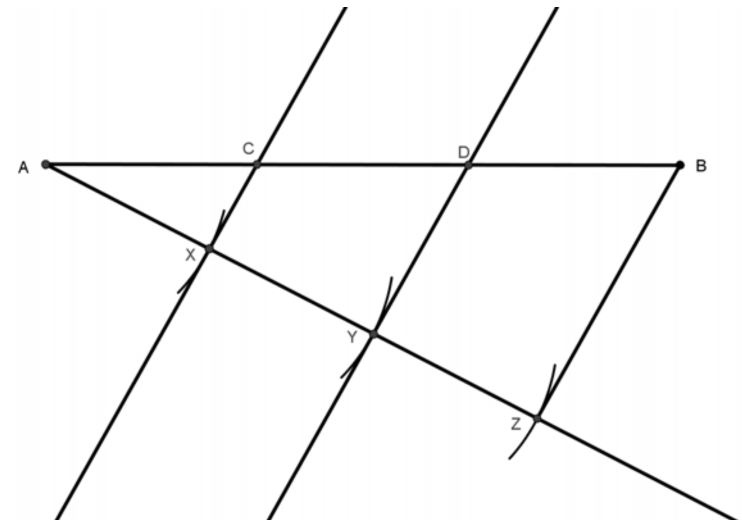
* Some steps may be indicated on candidate's diagram
* Must have one reason in Step 3 and A.S.A. in Step 4
* Accept other valid proofs

Blunders (-3)
B1 Each step incorrect or omitted
B2 Each step incomplete

Attempts (5 marks)
A1 Parallelogram drawn with diagonal indicated
A2 Parallelogram drawn with sides or angles to be proven equal indicated

Worthless (0)
W1 Wrong Theorem
W2 Parallelogram drawn only
W3 No diagram

(b) (ii) **5 marks** **Att 2**



*   Allow a tolerance of ±2 mm in constructions

Blunders (-3)
B1   Third arc not joined to B
B2   Each parallel line not shown in construction

Attempts (2 marks)
A1   Line divided into three equal parts with no construction lines shown

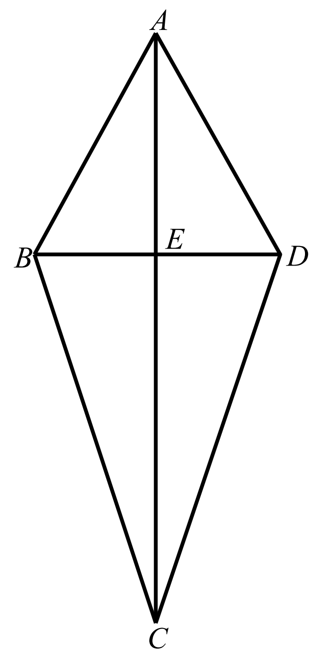
Worthless (0)
W1   Line drawn

Part (c) **10 (5,5) marks** **Att (2,2)**

In the diagram $|AB| = |AD|$ and $|BC| = |DC|$.
AC intersects BD at E.

(i) ✍ Prove $|\angle BAC| = |\angle DAC|$.

(ii) ✍ Prove E is the midpoint of $[BD]$.



(c) (i) **5 marks** **Att 2**

Consider triangles ABC and ADC

$|AB| = |AD|$ ....(given)

$|BC| = |DC|$ ....(given) Step 1

$|AC| = |AC|$.........................(common side) Step 2

$\therefore \Delta ABC \equiv \Delta ADC$..................S.S.S. Step 3

$\therefore |\angle BAC| = |\angle DAC|$...........(corresponding angles)

OR

$|\angle ABE| = |\angle ADE|$..................$(|AB| = |AD|)$

$|\angle CBE| = |\angle CDE|$..................$(|BC| = |DC|)$

$\Rightarrow |\angle ABE| + |\angle CBE| = |\angle ADE| + |\angle CDE|$

$\therefore |\angle ABC| = |\angle ADC|$

Consider triangles ABC and ADC

$|\angle ABC| = |\angle ADC|$ Step 1

$|AB| = |AD|$ ....(given)

$|BC| = |DC|$ ....(given) Step 2

$\therefore \Delta ABC \equiv \Delta ADC$................S.A.S. Step 3

$\therefore |\angle BAC| = |\angle DAC|$.....(corresponding angles)

* Some steps may be indicated on candidate's diagram
* Must have S.S.S. in Step 3 if Method 1 used
* Must have S.A.S. in Step 3 if Method 2 used

Blunders (-3)

B1 Each step incorrect or omitted
B2 Each step incomplete

Attempts (2 marks)
A1 Both triangles indicated or redrawn separately
A2 Indication of some knowledge of congruent triangles
A3 Indication of some knowledge of an isosceles triangle
A4 Equal sides or equal angles indicated on diagram

Worthless (0)
W1 Diagram from examination paper either partially or fully drawn

(c) (ii) **5 marks** **Att 2**

Consider triangles ABE and ADE

$|AB| = |AD|$ ....(given)
$|\angle BAE| = |\angle DAE|$.......(proven) Step 1
$|AE| = |AE|$ ....(common side)
$\therefore \Delta ABE \equiv \Delta ADE$ ...........S.A.S. Step 2
$\therefore |BE| = |DE|$ ....(corresponding sides) Step 3
$\therefore E$ is the midpoint of $[BD]$

OR

$\Delta ABC \equiv \Delta ADC \Rightarrow |\angle ACB| = |\angle ACD|$

Consider triangles BCE and CDE

$|BC| = |DC|$ ....(given)
$|\angle BCE| = |\angle DCE|$.... (proven) Step 1
$|CE| = |CE|$ ....(common side)
$\therefore \Delta BCE \equiv \Delta DCE$ .........S.A.S. Step 2
$\therefore |BE| = |DE|$ ....(corresponding sides) Step 3
$\therefore E$ is the midpoint of $[BD]$

* Some steps may be indicated on candidate's diagram
* Must have S.A.S. in Step 2

Blunders (-3)
B1 Each step incorrect or omitted
B2 Each step incomplete

Attempts (2 marks)
A1 Both triangles indicated or redrawn separately
A2 Indication of some knowledge of congruent triangles
A3 Indication of some knowledge of an isosceles triangle
A4 Equal sides or angles indicated on diagram

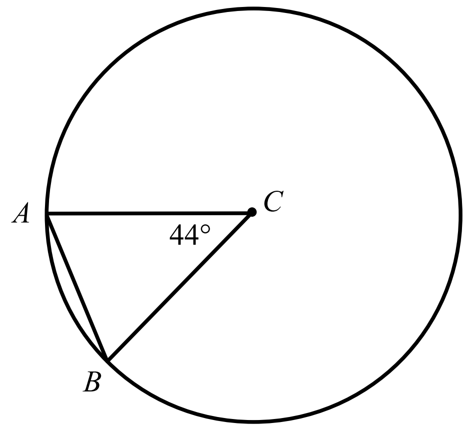
Worthless (0)
W1 Diagram from examination paper either partially or fully drawn

QUESTION 4

Part (a)	**25 marks**	**Att 8**
Part (b)	**15 marks**	**Att 5**
Part (c)	**10 marks**	**Att (2,2)**

Part (a) **25 marks** **Att 8**

A and B are points on a circle with centre C.
$|\angle BCA| = 44°$.
✍ Find $|\angle BAC|$.



(a) **25 marks** **Att 8**

$$|\angle BAC| = \frac{1}{2}(180 - 44)^{\circ}$$
$$= \frac{1}{2}(136)^{\circ}$$
$$= 68°$$

* Some steps may be indicated on candidate's diagram

Blunders (-3)

B1 Correct answer without work shown (✍)
B2 Sum of the angles in a triangle $\neq 180^{\circ}$

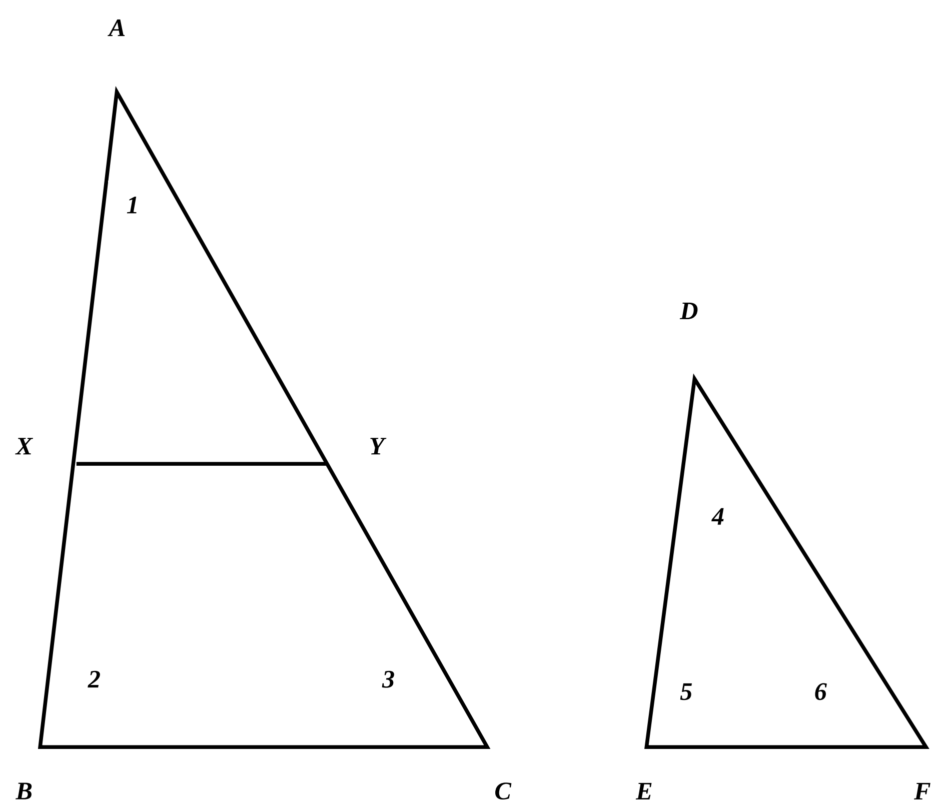
Attempts (8 marks)
A1 Indication that the sum of the angles in a triangle = 180°
A2 Indication of 136
A3 Mention of an isosceles triangle

Worthless (0)
W1 Diagram from examination paper either partially or fully drawn
W2 $|\angle BAC| = 90^{\circ}$

Part (b) **15 marks** **Att 5**

✍ Prove that if two triangles are equiangular, the lengths of corresponding sides are in proportion.

(b) **15 marks** **Att 5**



Given: Two triangles ABC and DEF in which $|\angle 1| = |\angle 4|$, $|\angle 2| = |\angle 5|$ and $|\angle 3| = |\angle 6|$

To Prove: $\frac{|AB|}{|DE|} = \left(\frac{|BC|}{|EF|}\right) = \frac{|AC|}{|DF|}$ Step 1

Construction: Mark the point X on $[AB]$ such that $|AX| = |DE|$
Mark the point Y on $[AC]$ such that $|AY| = |DF|$
Join X to Y Step 2

Proof: Consider triangles AXY and DEF
$|AX| = |DE|$ and $|AY| = |DF|$..............................(construction)
$|\angle 1| = |\angle 4|$ ....(given)
$\therefore$ The triangles AXY and DEF are congruent......S.A.S
$\therefore |\angle AXY| = |\angle DEF| = |\angle 5|$
(But $|\angle 2| = |\angle 5|$..given)
$\therefore |\angle AXY| = |\angle 2| = |\angle ABC|$
$\therefore XY \parallel BC$..(corresponding angles) Step 3

$\therefore \frac{|AB|}{|AX|} = \frac{|AC|}{|AY|}$ Step 4

$\therefore \frac{|AB|}{|DE|} = \frac{|AC|}{|DF|}$..........$\left(|AX| = |DE| \text{ and } |AY| = |DF|\right)$ Step 5

Similarly, it can be proven that $\frac{|AB|}{|DE|} = \frac{|BC|}{|EF|}$

$$\therefore \frac{|AB|}{|DE|} = \frac{|BC|}{|EF|} = \frac{|AC|}{|DF|}$$

* Some steps may be indicated on candidate's diagram
* Must have S.A.S in step 3
* Accept other valid proofs

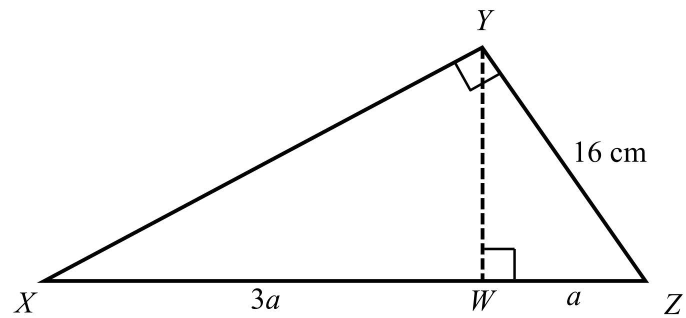
Blunders (-3)
B1 Each step incorrect or omitted
B2 Each step incomplete

Attempts (5 marks)
A1 Two separate diagrams drawn with equal angles indicated
A2 The second diagram of the proof drawn

Worthless (0)
W1 Wrong Theorem
W2 Two triangles drawn
W3 No diagram

Part (c) **10 (5,5) marks** **Att (2,2)**

XYZ is a right angled triangle with $|\angle XYZ| = 90°$.
W is a point on $[XZ]$, such that YW is perpendicular to XZ.



(i) ✍ Prove $\triangle XYZ$ and $\triangle WYZ$ are equiangular.

(ii) ✍ Given that $|WZ| = a$ cm, $|XW| = 3a$ cm and $|YZ| = 16$ cm, find a.

(c) (i) **5 marks** **Att 2**

Consider $\triangle XYZ$ and $\triangle WYZ$	
$\vert\angle XYZ\vert = \vert\angle YWZ\vert$ ....(90°)	Step 1
$\vert\angle XZY\vert = \vert\angle WZY\vert$ ....(common angle)	Step 2
$\vert\angle YXZ\vert = \vert\angle WYZ\vert$ ....(third pair of angles are equal)	
$\therefore \Delta XYZ$ and ΔWYZ are equiangular	Step 3

* Some steps may be indicated on candidate's diagram

Blunders (-3)
B1 Each step incorrect or omitted
B2 Each step incomplete

Attempts (2 marks)
A1 Both triangles indicated or redrawn separately

Worthless (0)
W1 Diagram from examination paper either partially or fully drawn

(c) (ii) **5 marks** **Att 2**

ΔXYZ and ΔWYZ are equiangular

$\therefore$ Corresponding sides are in proportion

$$\Rightarrow \frac{|XZ|}{|YZ|} = \frac{|YZ|}{|WZ|}$$

$$\Rightarrow \frac{4a}{16} = \frac{16}{a}$$

$$\Rightarrow 4a^2 = 256$$

$$\Rightarrow a^2 = 64$$

$$\Rightarrow a = 8$$

Blunders (-3)

B1 Correct answer without work shown (✍)
B2 Incorrect ratio
B3 Error in cross multiplication
B4 Error in square root

Slips (-1)

S1 Arithmetic slips to a maximum of *(-3)*

Attempts (2 marks)

A1 One correct relevant ratio
A2 Indication of $4a$

Worthless (0)

W1 Diagram from examination paper either partially or fully drawn

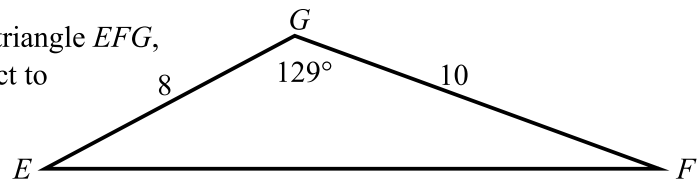
QUESTION 5

Part (a)	**10 marks**	**Att 3**
Part (b)	**20 marks**	**Att (3,3)**
Part (c)	**20 marks**	**Att (3,3)**

Part (a) **10 marks** **Att 3**

In the diagram $|\angle EGF| = 129°$,
$|EG| = 8$ and $|FG| = 10$.

✍ Calculate the area of the triangle EFG, giving your answer correct to one decimal place.



(a) **10 marks** **Att 3**

$$\text{Area triangle } EFG = \frac{1}{2}(8)(10)\sin 129° = 40\sin 129°$$
$$= 31\cdot 0858$$
$$= 31\cdot 1 \text{ units}^2$$

Blunders (-3)

B1 Correct answer without work shown (✍)
B2 Incorrect relevant formula
B3 Early rounding which affects the accuracy of the answer
B4 Calculator in incorrect mode

Slips (-1)

S1 Arithmetic slips to a maximum of *(-3)*
S2 Answer not rounded or incorrectly rounded

Attempts (3 marks)

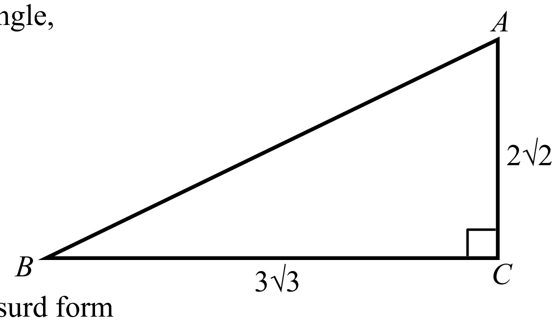
A1 Correct formula with some correct substitution

Worthless (0)

W1 Diagram from examination paper either partially or fully drawn
W2 Triangle treated as right-angled
W3 Incorrect formula with or without substitution

Part (b) **20 (10,10) marks** **Att (3,3)**

In the diagram *ABC* is a right angled triangle,
with *AC* perpendicular to *BC*.
$|AC| = 2\sqrt{2}$ and $|BC| = 3\sqrt{3}$.



Calculate

(i) ✍ $|AB|$, leaving your answer in surd form

(ii) ✍ $|\angle ABC|$, correct to the nearest degree.

(b) (i) **10 marks** **Att 3**

$$|AB|^2 = (3\sqrt{3})^2 + (2\sqrt{2})^2$$
$$= 27 + 8$$
$$= 35$$
$$|AB| = \sqrt{35}$$

Blunders (-3)

B1 Correct answer without work shown (✍)
B2 Error in Pythagoras' Theorem
B3 Error in squaring
B4 Error in square root

Slips (-1)

S1 Arithmetic slips to a maximum of *(-3)*
S2 Answer not in surd form

Attempts (3 marks)

A1 Effort at Pythagoras' Theorem

Worthless (0)

W1 Diagram from examination paper either partially or fully drawn

(b) (ii)	**10 marks**	**Att 3**

	$\tan \angle ABC = \dfrac{2\sqrt{2}}{3\sqrt{3}}$ or $0{\cdot}54433$	**OR**	$\cos\angle ABC = \dfrac{3\sqrt{3}}{\sqrt{35}}$ or $0 \cdot 8783$
OR	$\sin \angle ABC = \dfrac{2\sqrt{2}}{\sqrt{35}}$ or $0{\cdot}4781$	**OR**	$\dfrac{\sin \angle ABC}{2\sqrt{2}} = \dfrac{\sin 90^\circ}{\sqrt{35}}$ or $\sin \angle ABC = \dfrac{2\sqrt{2}}{\sqrt{35}}$ or $0 \cdot 4781$
	$\lvert\angle ABC\rvert = 28{\cdot}56^\circ = 29^\circ$		

* Accept candidate's answer from (b) (i)

Blunders (-3)

B1 Correct answer without work shown (✍)
B2 Incorrect ratio for sin/cos/tan function
B3 Incorrect ratio for Sine Rule
B4 Calculator in incorrect mode
B5 Early rounding which affects the accuracy of the answer

Slips (-1)

S1 Arithmetic slips to a maximum of *(-3)*
S2 Answer not rounded or incorrectly rounded

Attempts (3 marks)

A1 $\tan A = \dfrac{\text{opposite}}{\text{adjacent}}$ or $\cos A = \dfrac{\text{adjacent}}{\text{hypotenuse}}$ or $\sin A = \dfrac{\text{opposite}}{\text{hypotenuse}}$
A2 Sine rule with some correct substitution

Worthless (0)

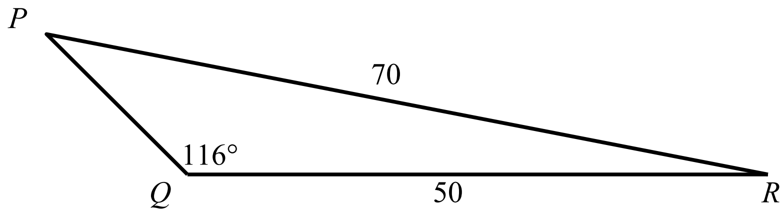
W1 Diagram from examination paper either partially or fully drawn

Part (c)	**20 (10,10) marks**	**Att (3,3)**

In the triangle PQR, $|PR| = 70$, $|QR| = 50$ and $|\angle PQR| = 116°$.

(i) ✍ Find $|\angle QPR|$, giving your answer correct to the nearest degree.

(ii) ✍ Find $|PQ|$, giving your answer correct to the nearest whole number.



(c) (i)	**10 marks**	**Att 3**

$$\frac{\sin\angle QPR}{50} = \frac{\sin 116^0}{70} \qquad \text{Step 1}$$

$$\sin\angle QPR = \frac{50\sin 116^\circ}{70} \quad \text{or} \quad 0\cdot641996 \qquad \text{Step 2}$$

$$|\angle QPR| = \sin^{-1}\left(\frac{50\sin 116^\circ}{70}\right) \quad \text{or} \quad \sin^{-1}(0\cdot641996)$$

$$= 39\cdot94^\circ$$

$$= 40^\circ \qquad \text{Step 3}$$

Blunders (-3)

B1 Correct answer without work shown (✍)
B2 Incorrect ratio for Sine Rule
B3 Calculator in incorrect mode
B4 Error in transposition
B5 Early rounding which affects the accuracy of the answer
B6 Each step incorrect
B7 Each step incomplete

Slips (-1)

S1 Arithmetic slips to a maximum of *(-3)*
S2 Answer not rounded or incorrectly rounded

Attempts (3 marks)

A1 Sine Rule with some correct substitution

Worthless (0)

W1 Diagram from examination paper either partially or fully drawn
W2 Triangle treated as right-angled

(c) (ii) **10 marks** **Att 3**

$$|\angle QRP| = 180^\circ - (40^\circ + 116^\circ) = 180^\circ - 156^\circ$$
$$= 24^\circ$$

$\dfrac{\lvert PQ \rvert}{\sin 24^\circ} = \dfrac{70}{\sin 116^\circ}$	**OR**	$\dfrac{\lvert PQ \rvert}{\sin 24^\circ} = \dfrac{50}{\sin 40^\circ}$	Step 1
$\lvert PQ \rvert = \dfrac{70 \sin 24^\circ}{\sin 116^\circ}$		$\lvert PQ \rvert = \dfrac{50 \sin 24^\circ}{\sin 40^\circ}$	Step 2
$\lvert PQ \rvert = 31{\cdot}6775$		$\lvert PQ \rvert = 31{\cdot}6385$	
	$\lvert PQ \rvert = 32$		Step 3

* Accept candidate's answer from (c) (i)

Blunders (-3)

B1 Correct answer without work shown (✍)
B2 Incorrect ratio for Sine Rule
B3 Calculator in incorrect mode
B4 Error in transposition
B5 Early rounding which affects the accuracy of the answer
B6 Each step incorrect
B7 Each step incomplete

Slips (-1)
S1 Arithmetic slips to a maximum of *(-3)*
S2 Answer not rounded or incorrectly rounded

Attempts (3 marks)
A1 Sine Rule with some correct substitution
A2 Indication that the sum of the angles in a triangle = 180°

Worthless (0)
W1 Diagram from examination paper either partially or fully drawn
W2 Triangle treated as right-angled

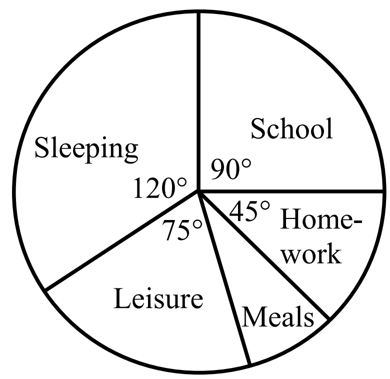
QUESTION 6

Part (a)	**10 marks**	**Att 3**
Part (b)	**20 marks**	**Att (3,3)**
Part (c)	**20 marks**	**Att (3,2,2)**

Part (a) **10 marks** **Att 3**

The pie chart shows how Mary spends her time over a typical 24 hour period.

✍ Copy and complete the following table in your answer book.



(a) **10 marks** **Att 3**

Sleeping: $\frac{120}{360} \times 24 = 8$

School: $\frac{90}{360} \times 24 = 6$

Homework: $\frac{45}{360} \times 24 = 3$

Leisure: $\frac{75}{360} \times 24 = 5$

Meals:

Angle $= 360^o - (120 + 90 + 45 + 75)^o$

$= 360^o - 330^o$

$= 30^o$

$\frac{30}{360} \times 24 = 2$

OR

Sleeping: $\frac{120}{360} \times 24 = 8$

School: $\frac{90}{360} \times 24 = 6$

Homework: $\frac{45}{360} \times 24 = 3$

Leisure: $\frac{75}{360} \times 24 = 5$

Meals: $24 - (8 + 6 + 3 + 5)$

$= 24 - 22$

$= 2$

	Sleeping	School	Homework	Meals	Leisure
No. of hours	**8**	**6**	**3**	**2**	**5**

Blunders (-3)

B1 Correct answer without work shown (✍)

B2 Sum of angles $\neq 360^o$

B3 Incorrect fraction

B4 Each entry omitted

Slips (-1)

S1 Arithmetic slips to a maximum of *(-3)*

Misreadings (-1)

M1 No table

Attempts (3 marks)

A1 Indication of 360^o

A2 Indication of 330^o or 30^o

Worthless (0)

W1 Diagram from examination paper either partially or fully drawn

Part (b) **20 (10,10) marks** **Att (3,3)**

The table below shows the results of a survey of the amount of money (in euro) that 150 people spent in a supermarket.

Amount (€)	0 – 10	10 – 15	15 – 20	20 – 30	30 – 50
No. of people	15	30	50	45	10

[Note: 10 ─ 15 means 10 or more but less than 15, etc.]

(i) ✍ Taking mid-interval values, calculate the mean amount of money spent in the supermarket.

(ii) ✍ Calculate the maximum percentage of the people who could have spent between €5 less than the mean and €5 more than the mean.

(b) (i) **10 marks** **Att 3**

The mid-interval values are: 5, 12·5, 17·5, 25, 40

$$\text{Mean} = \frac{(15\times 5)+(30\times 12\cdot 5)+(50\times 17\cdot 5)+(45\times 25)+(10\times 40)}{150}$$

$$= \frac{75+375+875+1125+400}{150}$$

$$= \frac{2850}{150}$$

$$= 19$$

The mean amount spent was €19

Blunders (-3)

B1 Correct answer without work shown (✍)
B2 Consistent incorrect mid-interval values
B3 Division by 5
B4 Division by sum of mid-interval values
B5 Mid-interval values added to frequencies instead of multiplied

Slips (-1)

S1 Arithmetic slips to a maximum of *(-3)*

Attempts (3 marks)

A1 One correct multiplication in numerator
A2 Indication of division by 150
A3 One correct mid-interval value
A4 Sum of mid-interval values divided by 150 or 5

Worthless (0)

W1 Sum of frequencies divided by 5

(b) (ii)	**10 marks**	**Att 3**

€5 less than mean: €19 − €5 = €14 €5 more than mean: €19 + €5 = €24	Step 1
Maximum number = 30 + 50 + 45 = 125	Step 2
Maximum percentage = $\frac{125}{150} \times 100\%$	
$= \frac{250}{3}\%$ or $83\frac{1}{3}\%$ or 83·3% or 83%	Step 3

* Accept candidate's answer from (b) (i)

Blunders (-3)

B1 Correct answer without work shown (✍)
B2 Each step incorrect
B3 Each step incomplete
B4 Omission of a number
B5 Extra number

Slips (-1)

S1 Arithmetic slips to a maximum of *(-3)*

Attempts (3 marks)

A1 Indication of 14 or 24 or equivalent
A2 Use of 100

Part (c) **20 (10,5,5) marks** **Att (3,2,2)**

A speed camera, situated in a 50 km/h speed limit zone, recorded the speed of the cars, in km/h, passing it over a one hour period. The following are the results:

36	72	43	62	56	57	65	50	47	56	62	59	46	43
25	54	47	51	56	52	48	53	49	39	57	76	37	49

(i) Copy and complete the cumulative frequency table in your answer book.

Speed	< 30	< 40	< 50	< 60	< 70	< 80
No. of cars		**4**		**23**		**28**

(ii) ✍ Use your cumulative frequency table to construct the ogive.

(iii) ✍ Use your ogive to estimate the number of cars with speeds between 45 and 55 km/h.

(iv) ✍ What is the difference between your estimate and the actual number of cars with speeds between 45 and 55 km/h?

(c) (i) **10 marks** **Att 3**

Speed	< 30	< 40	< 50	< 60	< 70	< 80
No. of cars	1	**4**	12	**23**	26	**28**

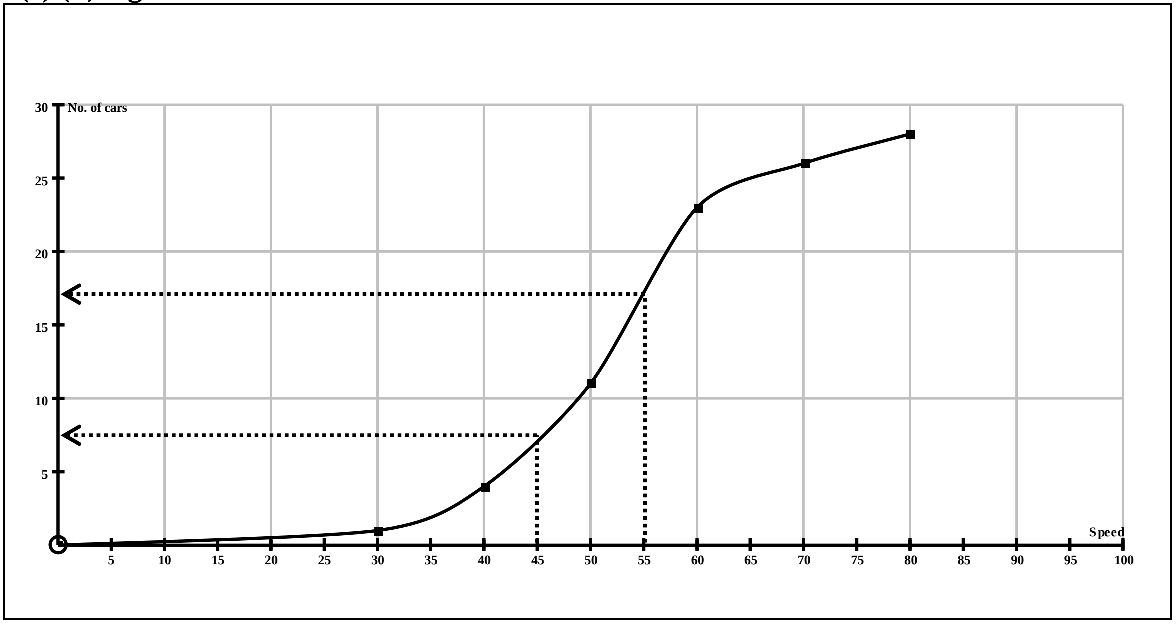
Blunders (-3)
B1 Omission of a value

Slips (-1)
S1 Arithmetic slips to a maximum of *(-3)*

Attempts (3 marks)
A1 Any one value filled into table
A2 Indication of counting values

Worthless (0)
W1 Table or list copied from examination paper

(c) (ii) Ogive **5 marks** **Att 2**



* Accept candidate's perpendicular axes
* Accept candidate's cumulative frequency table from (c) (i)

Blunders (-3)

B1 Scale not uniform on *y*-axis or above 30 on *x*-axis
B2 Points plotted but not joined
B3 Consistent error in plotting points

Slips (-1)

S1 Each point incorrectly plotted
S2 Each point omitted
S3 Points joined with straight lines
S4 Graph not drawn from origin

Attempts (2 marks)

A1 Scaled axes drawn

Worthless (0)

W1 Unscaled axes drawn

(c) (iii) & (iv) **5 marks** **Att 2**

Estimate of number of cars, with speeds between 45 and 55 from ogive: $17 - 8 = 9$

* Accept answer consistent with candidate's work in (c) (ii)
* Accept a tolerance of ± 2

Blunders (-3)

B1 Correct answer without work shown (✍)
B2 Line drawn from incorrect starting point on correct axis
B3 Lines not drawn

Slips (-1)
S1 Arithmetic slips to a maximum of *(-3)*
S2 Incorrect reading from graph with work shown
S3 Difference not found

Attempts (2 marks)
A1 Vertical line from 45 and/or 55 drawn

(c) (iv)

Actual number of cars with speeds between 45 and 55 is 11 The difference is $11 - 9 = 2$

* Accept candidate's answer from (c) (iii)