

Markscheme

November 2025

**Mathematics: applications
and interpretation**

Standard level

Paper 2

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Instructions to Examiners

Abbreviations

- M** Marks awarded for attempting to use a correct **Method**.
- A** Marks awarded for an **Answer** or for **Accuracy**; often dependent on preceding **M** marks.
- R** Marks awarded for clear **Reasoning**.
- AG** Answer given in the question and so no marks are awarded.
- FT** Follow through. The practice of awarding marks, despite candidate errors in previous parts, for their correct methods/answers using incorrect results.

Using the markscheme

1 General

Award marks using the annotations as noted in the markscheme eg **M1**, **A2**.

2 Method and Answer/Accuracy marks

- Do **not** automatically award full marks for a correct answer; all working **must** be checked, and marks awarded according to the markscheme.
- It is generally not possible to award **M0** followed by **A1**, as **A** mark(s) depend on the preceding **M** mark(s), if any.
- Where **M** and **A** marks are noted on the same line, e.g. **M1A1**, this usually means **M1** for an **attempt** to use an appropriate method (e.g. substitution into a formula) and **A1** for using the **correct** values.
- Where there are two or more **A** marks on the same line, they may be awarded independently; so if the first value is incorrect, but the next two are correct, award **A0A1A1**.
- Where the markscheme specifies **A3**, **M2** etc., do **not** split the marks, unless there is a note.
- The response to a “show that” question does not need to restate the **AG** line, unless a **Note** makes this explicit in the markscheme.
- Once a correct answer to a question or part question is seen, ignore further working even if this working is incorrect and/or suggests a misunderstanding of the question. This will encourage a uniform approach to marking, with less examiner discretion. Although some candidates may be advantaged for that specific question item, it is likely that these candidates will lose marks elsewhere too.
- An exception to the previous rule is when an incorrect answer from further working is used **in a subsequent part**. For example, when a correct exact value is followed by an incorrect decimal approximation in the first part and this approximation is then used in the second part. In this situation, award **FT** marks as appropriate but do not award the final **A1** in the first part.

Examples:

	Correct answer seen	Further working seen	Any FT issues?	Action
1.	$8\sqrt{2}$	5.65685... (incorrect decimal value)	No. Last part in question.	Award A1 for the final mark (condone the incorrect further working)

2.	$\frac{35}{72}$	0.468111... (incorrect decimal value)	Yes. Value is used in subsequent parts.	Award A0 for the final mark (and full FT is available in subsequent parts)
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3 Implied marks

Implied marks appear in **brackets e.g. (M1)**, and can only be awarded if **correct** work is seen or implied by subsequent working/answer.

4 Follow through marks (only applied after an error is made)

Follow through (**FT**) marks are awarded where an incorrect answer from one **part** of a question is used correctly in **subsequent** part(s) (e.g. incorrect value from part (a) used in part (d) or incorrect value from part (c)(i) used in part (c)(ii)). Usually, to award **FT** marks, **there must be working present** and not just a final answer based on an incorrect answer to a previous part. However, if all the marks awarded in a subsequent part are for the answer or are implied, then **FT** marks should be awarded for *their* correct answer, even when working is not present.

For example: following an incorrect answer to part (a) that is used in subsequent parts, where the markscheme for the subsequent part is **(M1)A1**, it is possible to award full marks for *their* correct answer, **without working being seen**. For longer questions where all but the answer marks are implied this rule applies but may be overwritten by a **Note** in the Markscheme.

- Within a question part, once an **error** is made, no further **A** marks can be awarded for work which uses the error, but **M** marks may be awarded if appropriate.
- If the question becomes much simpler because of an error then use discretion to award fewer **FT** marks, by reflecting on what each mark is for and how that maps to the simplified version.
- If the error leads to an inappropriate value (e.g. probability greater than 1, $\sin \theta = 1.5$, non-integer value where integer required), do not award the mark(s) for the final answer(s).
- The markscheme may use the word “their” in a description, to indicate that candidates may be using an incorrect value.
- If the candidate’s answer to the initial question clearly contradicts information given in the question, it is not appropriate to award any **FT** marks in the subsequent parts. This includes when candidates fail to complete a “show that” question correctly, and then in subsequent parts use their incorrect answer rather than the given value.
- Exceptions to these **FT** rules will be explicitly noted on the markscheme.
- If a candidate makes an error in one part but gets the correct answer(s) to subsequent part(s), award marks as appropriate, unless the command term was “Hence”.

5 Mis-read

If a candidate incorrectly copies values or information from the question, this is a mis-read (**MR**). A candidate should be penalized only once for a particular misread. Use the **MR** stamp to indicate that this has been a misread and do not award the first mark, even if this is an **M** mark, but award all others as appropriate.

- If the question becomes much simpler because of the **MR**, then use discretion to award fewer marks.
- If the **MR** leads to an inappropriate value (e.g. probability greater than 1, $\sin \theta = 1.5$, non-integer value where integer required), do not award the mark(s) for the final answer(s).
- Miscopying of candidates' own work does **not** constitute a misread, it is an error.
- If a candidate uses a correct answer, to a "show that" question, to a higher degree of accuracy than given in the question, this is NOT a misread and full marks may be scored in the subsequent part.
- **MR** can only be applied when work is seen. For calculator questions with no working and incorrect answers, examiners should **not** infer that values were read incorrectly.

6 Alternative methods

Candidates will sometimes use methods other than those in the markscheme. Unless the question specifies a method, other correct methods should be marked in line with the markscheme. If the command term is 'Hence' and not 'Hence or otherwise' then alternative methods are not permitted unless covered by a note in the mark scheme.

- Alternative methods for complete questions are indicated by **METHOD 1**, **METHOD 2**, etc.
- Alternative solutions for parts of questions are indicated by **EITHER . . . OR**.

7 Alternative forms

Unless the question specifies otherwise, **accept** equivalent forms.

- As this is an international examination, accept all alternative forms of **notation** for example 1.9 and 1,9 or 1000 and 1,000 and 1.000.
- Do not accept final answers written using calculator notation. However, **M** marks and intermediate **A** marks can be scored, when presented using calculator notation, provided the evidence clearly reflects the demand of the mark.
- In the markscheme, equivalent **numerical** and **algebraic** forms will generally be written in brackets immediately following the answer.
- In the markscheme, some **equivalent** answers will generally appear in brackets. Not all equivalent notations/answers/methods will be presented in the markscheme and examiners are asked to apply appropriate discretion to judge if the candidate work is equivalent.

8 Format and accuracy of answers

If the level of accuracy is specified in the question, a mark will be linked to giving the answer to the required accuracy. If the level of accuracy is not stated in the question, the general rule applies to final answers: *unless otherwise stated in the question all numerical answers must be given exactly or correct to three significant figures*.

Where values are used in subsequent parts, the markscheme will generally use the exact value, however candidates may also use the correct answer to 3 sf in subsequent parts. The markscheme will often explicitly include the subsequent values that come “*from the use of 3 sf values*”.

Simplification of final answers: Candidates are advised to give final answers using good mathematical form. In general, for an **A** mark to be awarded, arithmetic should be completed, and any

values that lead to integers should be simplified; for example, $\sqrt{\frac{25}{4}}$ should be written as $\frac{5}{2}$. An exception to this is simplifying fractions, where lowest form is not required (although the numerator and the denominator must be integers); for example, $\frac{10}{4}$ may be left in this form or written as $\frac{5}{2}$.

However, $\frac{10}{5}$ should be written as 2, as it simplifies to an integer.

Algebraic expressions should be simplified by completing any operations such as addition and multiplication, e.g. $4e^{2x} \times e^{3x}$ should be simplified to $4e^{5x}$, and $4e^{2x} \times e^{3x} - e^{4x} \times e^x$ should be simplified to $3e^{5x}$. Unless specified in the question, expressions do not need to be factorized, nor do factorized expressions need to be expanded, so $x(x+1)$ and $x^2 + x$ are both acceptable.

Please note: intermediate **A** marks do NOT need to be simplified.

9 Calculators

A GDC is required for this paper, but if you see work that suggests a candidate has used any calculator not approved for IB DP examinations (eg CAS enabled devices), please follow the procedures for malpractice.

10 Presentation of candidate work

Crossed out work: If a candidate has drawn a line through work on their examination script, or in some other way crossed out their work, do not award any marks for that work unless an explicit note from the candidate indicates that they would like the work to be marked.

More than one solution: Where a candidate offers two or more different answers to the same question, an examiner should only mark the first response unless the candidate indicates otherwise. If the layout of the responses makes it difficult to judge, examiners should apply appropriate discretion to judge which is “first”.

1. (a) (i) 42 (km) A1

(ii) $(\varepsilon =) \left| \frac{42 - 42.19}{42.19} \right| \times 100\%$ (M1)

0.450 (%) (0.450343...(%)) A1

Note: Award (M1) for correct substitution of their part (a)(i) into percentage error formula.

[3 marks]

(b) **METHOD 1**
 attempt to substitute into arithmetic sequence formula (M1)
 $42 = 6 + (n - 1) \times 2$ **OR** $42 = 2n + 4$ (A1)
 $(n =) 19$ A1

METHOD 2
 list of any consecutive terms ending on/above 42 (M1)
 at least two correct terms (not including 6, 8 and 10) (A1)
 $(n =) 19$ A1

[3 marks]

(c) **METHOD 1**
 $(S_{10} =) \frac{10}{2} (2 \times 6 + (10 - 1) 2)$ (A1)
 150(km) A1

METHOD 2
 summing (some) correct terms up to 24 **OR** list of correct cumulative values (A1)
 $6 + 8 + 10 + \dots + 24$ **OR** 6, 14, 24, 36....
 150 (km) A1

[2 marks]

(d) **METHOD 1**

$$3(1.2)^{n-1} \quad (A1)$$

Note: Award **(A1)** for correct substitution into geometric sequence formula.

comparing their geometric expression to 42 **(M1)**

e.g. $3(1.2)^{n-1} > 42$ **OR** $3(1.2)^{n-1} = 42$

($n =$) 15.4747... seen **OR** 38.5175... and 46.2210... seen (from table) **(A1)**

16 (weeks) **A1**

METHOD 2

List of values see. At least 3, 3.6, 4.32 etc **(M1)(A1)**

38.5175... and 46.2210... seen **(A1)**

16 (weeks) **A1**

[4 marks]

(e) **METHOD 1**

attempt to substitute into geometric series formula **(M1)**

Note: **FT** their r from (d).

$$150 < \frac{3(1-1.2^n)}{1-1.2} \quad \mathbf{OR} \quad 150 = \frac{3(1-1.2^n)}{1-1.2} \quad \mathbf{OR} \quad 13.1520... \quad (A1)$$

14 (weeks) **A1**

METHOD 2

evidence using tables in GDC or adding the first 14 terms **(M1)**

both crossover values seen, e.g 145.589... and 177.587... **(A1)**

14 (weeks) **A1**

[3 marks]

Total [15 marks]

2. (a) 0.648 (0.64848...) A2

strong positive (correlation between the ranks (of the data)) A1A1

Note: Award **A1A0** if only the strength is correctly commented upon. **FT** their value for r .

[4 marks]

(b) evidence of constructing N from separate shapes (M1)
rectangle minus 2 triangles **OR** two rectangles + parallelogram

$$13 \times 14 - 2 \left(\frac{1}{2} \times 7 \times 5 \right) \text{ OR } 2(4 \times 14) + 7 \times 5 \quad \text{A1}$$

$$147 \text{ (cm}^2\text{)} \quad \text{A1}$$

[3 marks]

(c) 588 (cm³) A1

[1 mark]

(d) (i) $H_0 : \mu_A = \mu_B$; $H_1 : \mu_A \neq \mu_B$ A1A1

Note: Accept an equivalent statement in words, however reference to “**population mean**” must be explicit for both **A1** marks to be awarded.
Award at most **A1A0** for an imprecise “*the means are (not) equal*”.
Accept μ_1 in place of μ_A and μ_2 in place of μ_B .

(ii) $p = 0.102$ (0.101900...) A2

(iii) $p\text{-value} > \text{significance level or } 0.05$ **OR** $0.102 > 0.05$ R1
insufficient evidence to reject null hypothesis A1

Note: Do not award **R0A1**.
Their conclusion must be consistent with their hypothesis and their p -value.
Do not accept a p -value > 1

[6 marks]

Total [14 marks]

3. (a) **Cosine rule and area of triangle formula**

attempt to use cosine rule to find an angle

(M1)

EITHER

$$(\theta =) \cos^{-1} \left(\frac{1600^2 + 1500^2 - 1400^2}{2 \times 1600 \times 1500} \right) (= 53.5764...^{\circ}) \quad (A1)$$

attempt to use area of triangle formula for **their angle**/expression

(M1)

$$(A =) \frac{1}{2} 1600 \times 1500 \times \sin(53.57642636...^{\circ}) \quad (A1)$$

OR

$$(\theta =) \cos^{-1} \left(\frac{1400^2 + 1500^2 - 1600^2}{2 \times 1400 \times 1500} \right) (= 66.8676...^{\circ}) \quad (A1)$$

attempt to use area of triangle formula for **their angle**/expression

(M1)

$$(A =) \frac{1}{2} 1400 \times 1500 \times \sin(66.8676036...^{\circ}) \quad (A1)$$

OR

$$(\theta =) \cos^{-1} \left(\frac{1600^2 + 1400^2 - 1500^2}{2 \times 1600 \times 1400} \right) (= 59.5559...^{\circ}) \quad (A1)$$

attempt to use area of triangle formula for their angle/expression

(M1)

$$(A =) \frac{1}{2} 1400 \times 1600 \times \sin(59.5559...^{\circ}) \quad (A1)$$

THEN

$$966000 \text{ (965579...)}(m^2) \quad (A1)$$

$$9.66 \times 10^5 \text{ (9.65579...} \times 10^5)(m^2) \quad A1$$

Note: Follow through within the question for correctly converting their intermediate value into standard form (but only if their pre-conversion value is seen).

[6 marks]

(b) $\sqrt{300^2 + 200^2}$ **OR** $300^2 + 200^2 = d^2$ (A1)
 361 (360.555...) (m) A1

[2 marks]

(c) $360.555... \times 2 \times (\$)120$ (A1)
 (\$)86533.2...
 (\$)86533 A1

Note: Accept 86640, 86544, and 86534,
 (from use of 3 sf, 4sf and 5sf answer to part(b), respectively).

[2 marks]

(d) (i) $1750 \times 60 - 86533$
 (\$)18467

(A1)
 A1

Note: Accept 18360, 18456, and 18466, from 3sf, 4sf and 5sf answers to part (b).

(ii) $N = 60$
 $PV = (\mp)86533$
 $FV = 0$
 $PMT = (\pm)1750$
 $P/Y = 12$
 $C/Y = 12$

(M1)(A1)

Note: Award **M1** for an attempt to use a financial app (at least 3 entries, not necessarily correct) or an attempt to use an annuity formula.
 Award **A1** for all entries correct in financial app or correct substitution in an annuity formula.
 Award **M0** for a substituted compound interest formula only.

7.89(%) (7.88938....)

A1

Note: Accept 7.84(%) and 7.88(%), from 3sf and 4sf answers to part (b).

[5 marks]
 Total [15 marks]

4. (a) $\frac{1.26 - (-0.26)}{2}$ OR $\frac{1.52}{2}$ (A1)
0.76 A1
[2 marks]

(b) $\frac{1.26 + (-0.26)}{2}$ (A1)
0.5 A1
[2 marks]

(c) **METHOD 1**
attempt to subtract the times at the minimum and maximum (M1)
 $10:48 - 03:36 (= 7:12)$
 $(7:12 \times 2 =) 14:24$ (A1)
14.4 A1

METHOD 2
correct conversion of at least one time in hours, e.g 10.8 or 3.6 seen (A1)
attempt to subtract their times (M1)
 $10.8 - 3.6 (= 7.2)$
 $(7.2 \times 2 \text{ or } 3.6 \times 4 =) 14.4$ A1

[3 marks]

(d) $\frac{360}{14.4}$ OR $\frac{2\pi}{14.4}$ (A1)

Note: Award full marks for (d), (e) and (g) if radians used. **FT** from their (c).

$(b =) 25$ (seen, including in an incorrect equation) OR 0.436 ($0.436332\dots$) (A1)

$h(t) = 0.76 \sin(25t) + 0.5$ OR $h(t) = 0.76 \sin(0.436t) + 0.5$ A1

Note: Do not accept y and x in place of $h(t)$ and t .

[3 marks]

(e) attempt to substitute 2.5 into their equation (M1)

Note: If they lost the mark in (c) because they did not convert to real number, **AND** substitute 2.3 in the formula, then award full **FT** marks.

$(h(2.5) =) 0.76 \sin(25 \times 2.5) + 0.5$ OR $0.76 \sin(0.436 \times 2.5) + 0.5$
1.17 ($1.17412\dots$)(m) A1
[2 marks]

- (f) the road is above the water-level **OR** the island is accessible **OR**
cars can drive on the road

R1

Note: Accept equivalent statements.

[1 mark]

- (g) setting their equation to zero
 $0 = 0.76 \sin(25t) + 0.5$ **OR** $0 = 0.76 \sin(0.436332 \dots t) + 0.5$
 $t = 8.84558 \dots, t = 12.7544 \dots, t = 23.2455 \dots$

(M1)

(A1)(A1)

Note: Award **A1A0** if only one or two correct t -values are seen.

finding differences between t -values
 $12.7544 \dots - 8.84558 \dots$ **OR** $24 - 23.2455 \dots$
 4.66 ($4.66325 \dots$) (hours)

(M1)

A1

Note: Answer does not need to be in minutes, but accept “4 hours 40 minutes” or “280 minutes” as a correct final answer.

Award **(M1)(A1)A0(M1)A0** for an answer of “3.91 hours”, “3 hours and 55 minutes”, or “235 minutes” (i.e., only considering first minimum).

[5 marks]

Total [18 marks]

5. (a) (i) $\int_0^{60} 0.001x^3 - 0.12x^2 + 4.05x + 3 \, dx$ OR $\int_0^{60} f(x) \, dx$ **A1A1**

Note: Award **A1** for $\int_0^{60}$, **A1** for $0.001x^3 - 0.12x^2 + 4.05x + 3$ or " $f(x)$ " and dx .

- (ii) 2070 (m²) **A2**
[4 marks]

- (b) (i) $x = 24.2$ (24.1886...), $y = 44.9$ (44.9056...) or (24.2, 44.9) **A1A1**

Note: Award **A1A0** if parentheses are omitted.

- (ii) attempt to use inverse tangent **(M1)**

$$\tan^{-1}\left(\frac{y}{x}\right)$$

- 61.7° (61.6907...°) **A1**
[4 marks]

- (c) **METHOD 1**
attempt to use trapezoidal rule, for $h = 20$. **(M1)**

$$\frac{1}{2}(20)((3 + 30) + 2(44 + 37))$$
 (A1)

1950 (m²) **A1**

- METHOD 2**
attempt to find area of three trapezoids, each with $h = 20$ **(M1)**
correct expressions of values seen **(A1)**

$$\frac{1}{2}(3 + 44)20, \frac{1}{2}(44 + 37)20, \frac{1}{2}(37 + 30)20 \text{ OR } 470, 810, 670$$

1950 (m²) **A1**
[3 marks]

(d) recognition of need to integrate (e.g. reverse power rule or integral symbol) **(M1)**

$$\int -0.00292a + 4.71 \, da = -0.00146a^2 + 4.71a (+c) \quad \textbf{(A1)(A1)}$$

Note: Award **A1** for each correct term.

$$1750 = -0.00146(500)^2 + 4.71(500) + c \quad \textbf{(M1)}$$

Note: Award **M1** for correct substitution of 500 **and** 1750 into their expression.
A constant of integration must be seen (can be implied by a correct c value seen).

$$\begin{aligned} c &= -240 \\ (C(a) &=) -0.00146a^2 + 4.71a - 240 \end{aligned} \quad \begin{array}{l} \textbf{(A1)} \\ \textbf{[5 marks]} \end{array}$$

$$(e) \quad (C(1950) =) -0.00146(1950)^2 + 4.71(1950) - 240 \quad \textbf{(A1)}$$

Note: Award **A1** for correctly substituting their part (c) into their $C(a)$ from part (d).

$$(\$) 3390 \text{ (3392.85)} \quad \begin{array}{l} \textbf{A1} \\ \textbf{[2 marks]} \\ \textbf{Total [18 marks]} \end{array}$$