2225 – 7310M

Diploma Programme
Programme du diplôme
Programa del Diploma

Markscheme

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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)*

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) $(k =)\ 5$ ***A1***

[1 mark]

(b) (i) attempt to substitute into the mean formula with a sum of at least two correct products **and** equating to 2.2 (or $2.2\ (p+27)$ if denominator not seen) or equating to "mean". Equation may be seen in part b(ii). ***(M1)***

$$2.2 = \frac{0\times 3+1\times 11+2\times 7+3\times 5+4\times p+5\times 1}{3+11+7+5+p+1} \quad \textbf{OR} \quad 2.2 = \frac{45+4p}{p+27}$$ ***A1***

(ii) $(p =)\ 8$ ***A1***

Note: Follow through from part (b)(i) only if their value of p is a whole number.

[3 marks]

(c) finding the median $(=2)$, quartiles ($Q_1 = 1$ and $Q_3 = 4$), or interquartile range of the data $IQR = 3$ from the 2024 tournament ***(A1)***

Note: Award ***(A1)*** for any correctly identified/labelled value referring to 2024 data as listed in the question. Accept "Range from 0 to 5" without reference to 2024.

Any two of the following statements: ***R1R1***

The median number of goals per game **in both years** is 2.
In both years, (the lower quartile is 1 and the upper quartile is 4) the IQR is 3.
Both distributions are (roughly) skewed to the right

Note: Award ***R1*** for each correct statement. Each statement must reference values from both the box and whisker diagram **and** the data from the 2024 tournament to award ***R1***. (e.g. "the median is 2" earns ***R0***, "the median for both years is 2" earns ***R1***.) If an incorrect statement is made, award at most ***R1R0***.

[3 marks]

(d) B and C ***A1A1***

Note: Award ***A1*** for each correct event, if one or two events are selected.
Award ***A1A0*** for two correct events and one additional incorrect event selected.
Award ***A0A1*** for an answer of "A, D, and E" from misreading the meaning of F'.
Award ***A0A0*** for any other combination of events selected.

[2 marks]

(e) $\frac{5}{17}\left(\frac{10}{34}\right)$ ***A1A1***

Note: Award ***A1*** for correct numerator, ***A1*** for correct denominator. Award at most ***A1A0*** for a decimal answer $(0.294117\ldots)$ if no fraction is shown. Do not award ***A1ft*** for their denominator if their answer to part (a) or part (b)(ii) is not a whole number.

[2 marks]

(f) $\frac{1}{35}\times\frac{3}{34}$ ***(A1)(A1)(M1)***

Note: Award ***A1*** for each correct probability, ***M1*** for multiplying their two probabilities. Do not award any marks if their answer to part (a) or part (b)(ii) is not a whole number.

$0.00252 \quad (0.00252100\ldots, \frac{3}{1190}, 0.252\%)$ ***A1***

[4 marks]
Total [15 marks]

2. (a) **EITHER**

$N = 72$ ***(M1)(A1)***

$I\% = 3.4$

$PV = \pm 10\,000$

$P/Y = 12$

$C/Y = 12$

Note: Award ***M1*** for an attempt to use a financial app in their technology (i.e., at least three entries seen, but not necessarily correct), ***A1*** for all entries correct.

OR

$N = 72$ ***(M1)(A1)***

$I\% = 3.4/12$

$PV = \pm 10\,000$

$P/Y = 1$

$C/Y = 1$

Note: Award ***M1*** for an attempt to use a financial app in their technology (i.e., at least three entries seen, but not necessarily correct), ***A1*** for all entries correct.

OR

attempt to substitute into the compound interest formula ***(M1)***

$FV = 10\,000 \times \left(1 + \frac{3.4}{100 \times 12}\right)^{6 \times 12}$ ***(A1)***

THEN

($FV =$) 12 259 (CAD) ***A1***

[3 marks]

(b) 212 741 (CAD) ***A1***

[1 mark]

(c) $N = 180$ ***(M1)(A1)(A1)(A1)***
$FV = 0$
$I\% = 6.4$
$PV = \pm 212\,741$
$P/Y = 12$
$C/Y = 2$

Note: Award ***M1*** for attempt to use a financial app with at least three entries seen, but not necessarily correct, ***A1*** for N **and** I, ***A1*** for P/Y **and** C/Y, ***A1*** for their PV from (b) **and** $FV = 0$. Approaches that use the compound interest formula receive no marks.

$(PMT =)\ 1832$ (CAD) ***A1***

Note: Accept -1832 (CAD).

[5 marks]

(d) (i) $N = 36$ ***(M1)(A1)***
$PV = \pm 194\,572$
$PMT = 2200$

Note: Award ***M1*** for adjusting at least one of N, PV, or PMT; ***A1*** for correct entries (PV and PMT must have opposite signs). Allow ***FT*** from incorrect entries for P/Y and/or C/Y from part (c).

$(FV =) 148\,099$ (CAD) ***(A1)***
$(194\,572 - 148\,099)$

46 473 (CAD) ***A1***

(ii) $2200 \times 12 \times 3\ (= 79\,200)$ ***(A1)***
$(79\,200 - 46\,473 =)$

32 727 (CAD) ***A1***

[6 marks]
Total [15 marks]

3. (a) **EITHER**
The ratio of consecutive terms is constant. ***R1***

OR
Each term of the sequence is found by multiplying the previous term by a constant. ***R1***

Note: Do not accept "it has a common ratio" unless it is stated or illustrated that the ratio is between consecutive terms. Do not accept "because $r = 1.05$" or " because each subsequent day that he runs he increases his distance by 5%" for the explanation. The explanation must refer to a constant ratio or repeated multiplication by a constant.

THEN
$r = 1.05$ ***A1***

Note: Award ***R0A1*** for $r = 1.05$ seen with incorrect or no explanation.

[2 marks]

(b) attempt to substitute into the sum formula for geometric sequence **OR**
attempt to write the sum in sigma notation using the term formula **OR** a sum of geometric sequence terms ***(M1)***

$(S_{15} =) \dfrac{2\left(1.05^{15} - 1\right)}{1.05 - 1}$ **OR** $\sum_{1}^{15}(2 \times 1.05^{n-1})$ **OR** $2 + 2 \times 1.05 + 2 \times 1.05^2 + ...$

$43.2\ (\text{km})$ $(43.1571\ldots\ (\text{km}))$ ***A1***

[2 marks]

(c) choosing $n = 36$ ***(A1)***

attempt to substitute into term formula for geometric sequence ***(M1)***
$(u_{36} =)\ 2 \times 1.05^{36-1}$

$11.0\ (11.0320\ldots) > 5 \times 2$ **OR** 11.0 verbally compared to 5×2 ***A1***

Note: Award at most ***A1M1A0*** if a final distance $(11.0$ or $11)$ is not given or if the comparison to 10 (5×2) is not shown. Accept 11 for u_{36} (correct 2sf answer).

[3 marks]

(d) (i) recognition of swimming out and back **AND/OR** swimming two times per week ***(M1)***

$(u_1 =)\ 80 \times 2 \times 2$

$(u_1 =)\ 320\,(\text{m})$ ***A1***

(ii) attempt to substitute into term formula of arithmetic sequence ***(M1)***

$704 = 320 + (4 - 1)\,d$ **OR** $\frac{704-320}{3}$ ***(A1)***

Note: Equating to 704 must be seen to award the ***(A1)***.

$(d =)\ 128\ (\text{m})$ ***A1***

(iii) **METHOD 1: Using increased swimming distance**

$(128 \div 2 \div 2 =)\ 32\ (\text{m})$ (further each week) ***(A1)***

$(80 + 32 =)\ 112\ (\text{m})$ (from the shore in week 2) ***A1***

METHOD 2: Using total swimming distance for week 2

$(320 + 128 =)\ 448\ (\text{m})$ (swam in week 2) ***(A1)***

$(448 \div 2 \div 2 =)\ 112\ (\text{m})$ (from the shore in week 2) ***A1***

[7 marks]

(e) **METHOD 1: Using sequence for distance swam per week (i.e. 320, 448, 576…)**

attempt to substitute *their* answers from (d)(i) and (d)(ii) into term formula ***(M1)***

$(u_{12} =)\ 320 + (12 - 1) \times 128$

$1728\ (\text{m})$ (for the week) ***(A1)***

$864\ (\text{m})$ (on a day in week 12) ***A1***

METHOD 2: Using a sequence (t_n) for distance swam per day each week (i.e. 160, 224, 288…)

recognizing $t_1 = 160$ and $d = 64$ ***(A1)***

attempt to substitute 160 and 64 into term formula ***(M1)***

$(t_{12} =)\ 160 + (12 - 1) \times 64$

$864\ (\text{m})$ (on a day in week 12) ***A1***

METHOD 3: **Using a sequence (v_n) for distance of marker from shore each week (i.e. 80, 112, 144…)**

attempt to substitute 80 and 32 into term formula ***(M1)***

$(v_{12} =)\ 80 + (12 - 1) \times 32$

(marker is) $432\ (\text{m})$ (from shore) ***(A1)***

$(432 \times 2 =)\ 864\ (\text{m})$ (on a day in week 12) ***A1***

[3 marks]

[Total: 17 marks]

4. (a) $(4, 1, 0)$ ***A1A1***

Note: Award ***A1*** for 4 seen as the x-coordinate or 1 seen as the y- coordinate, ***A1*** for all coordinates correct and in the correct order. Accept $x = 4, y = 1, z = 0$.

[2 marks]

(b) correct substitution into distance formula ***(A1)***
$\sqrt{(13-13)^2 + (25-1)^2 + (7-0)^2}$ **OR** $\sqrt{0^2 + 24^2 + 7^2}$

Note: Accept omission of $(13-13)^2$ or 0^2.

$(\text{AC} =)\ 25\ (\text{cm})$ ***A1***

[2 marks]

(c) **Method 1**
24 and 7 seen ***A1***

$24^2 + 7^2 = 25^2$ **OR** $625 = 625$ **OR** (angle $\text{B} =)\ \cos^{-1}\left(\frac{7^2 + 24^2 - 25^2}{2(7)(24)}\right) = 90^\circ$ ***R1***

Note: Accept $\text{AB}^2 + \text{BC}^2 = 625$ as long as the length of AB and of BC are defined.

therefore ΔABC must be a right-angled triangle ***AG***

Method 2

A relevant statement describing $\vec{\text{AB}}$ and $\vec{\text{BC}}$, such as:
$\text{AB} \parallel y$-axis **AND** $\text{BC} \parallel z$-axis
OR
x-coordinates are the same for A and B **AND** y-coordinates are the same for B and C ***A1***
AB perpendicular to BC since x-axis is perpendicular to z-axis ***R1***
therefore ΔABC must be a right-angled triangle ***AG***

[2 marks]

(d) width of 9 or correct cross-section area (84) seen ***(A1)***

correct substitution into volume formula ***(A1)***
$V = \frac{1}{2}(24)(7)(9)$

$(\text{Volume} =) 756\ \text{cm}^3$ ***A1***

Note: Do not award final ***A1*** if correct units are not included.

[3 marks]

(e) correct substitution using *their* AB from part (c) or (d) and *their* original volume from part (d) ***(A1)***

$(\text{AX} =)\ 24 \times \sqrt{\frac{625}{756}}$

$21.8\ (\text{cm})\quad (21.8217\ldots\ (\text{cm}))$ ***A1***

[2 marks]

(f) multiplying 625 by 1.1 or 1.2 or 0.025 ***(M1)***

$625 \times 1.1 \times 0.025 \times 1.2$ ***(A1)***

(price $=$) $20.63\ \ (20.625)$ (USD) ***A1***

[3 marks]

[Total 14 marks]

5. (a) (i) attempt to substitute any given coordinates into midpoint formula ***(M1)***

$(12, 12.5)$ or $(12, \frac{25}{2})$ ***A1***

Note: Award ***A0*** if parentheses are omitted.

(ii) attempt to find gradient of BC using coordinates of B and C ***(M1)***

(gradient of $\mathrm{BC}=$) $\frac{12-13}{16-8}\left(=-\frac{1}{8}=-0.125\right)$ ***(A1)***

(gradient of $\perp=$) 8 ***A1***

Note: Follow through within question part for final ***A1*** from their gradient of BC only if the gradient is seen.

(iii) **EITHER**

$8(x-12)=y-12.5 \quad \left(8(x-12)=y-12\frac{1}{2}\right)$ ***A1***

OR

$y=8x-83.5 \quad \left(y=8x-83\frac{1}{2}\right)$ ***A1***

[6 marks]

(b) (i) **EITHER**

B is expected to respond since $(14, 10)$ lies in the same cell (of the Voronoi diagram) as fire station B ***R1***

OR

B is expected to respond since $(14, 10)$ is closer to B than to any other fire station ***R1***

OR

B is expected to respond since it's the closest (nearest responder) to $(14, 10)$ ***R1***

OR

Fire station B will respond as the fire is within B's boundaries/area/region. ***R1***

Note: Do not award ***R1*** unless the statement refers to both the distance (closer) to B (or located in the B cell) **and** the responder (point B or fire station B) For example, award ***R0*** for "Point B is closer to $(14, 10)$" as there is no reference to a responder.

(ii) *Award **R1** for any viable reason such as:*

- fire station B might have already responded to a different fire
- a different fire station might have more manpower or equipment available to fight the fire
- a different fire station might respond to assist fire station B if the fire is large
- the Voronoi diagram only considers straight-line distances, so a different fire station might have a shorter driving route to the fire ***R1***

[2 marks]

(c) (i) attempt to calculate the length DB ***(M1)***

a correct expression for DB ***A1***

$(\mathrm{DB}=)\ \sqrt{\left(11\frac{1}{3}-16\right)^2+\left(7\frac{1}{6}-12\right)^2}$

$\mathrm{DB}=6.71855$ ***AG***

(ii) **METHOD 1**

$(\mathrm{DC}=)\ \sqrt{\left(11\frac{1}{3}-8\right)^2+\left(7\frac{1}{6}-13\right)^2}$ ***A1***

$\mathrm{DC}=6.71855$ therefore, the fire is equidistant from all 3 fire stations ***R1***

so, any of the fire stations would be expected to respond ***AG***

Note: Do not award ***A0R1***. Do not award ***R1*** if ***AG*** statement is not seen.

METHOD 2

The intersection of bisector AB and bisector BC:

$y=8x-83.5$ and $y=0.5x+1.5$ have an intersection at $\mathrm{D}\left(11\frac{1}{3},\ 7\frac{1}{6}\right)$ ***A1***

Note: Calculator solve is acceptable but D must be clearly identified from a calculation of intersecting lines.

Since D is the intersection of the bisector lines, the fire at D is equidistant from all 3 fire stations ***R1***

so, any of the fire stations would be expected to respond ***AG***

Note: Do not award ***A0R1.*** Do not award ***R1*** if ***AG*** statement is not seen.

[4 marks]

(d) (i) **METHOD 1: Dividing into two triangles**

$(0.5\times 20+1.5=)\ 11.5$ seen in an area calculation ***(A1)***

$(20-7.75=)\ 12.25$ or $(20-11.3333\ldots=)\ 8.66666\ldots$ seen ***(A1)***

substitution into triangle area formula for either triangle ***(M1)***

$(A=)\ 0.5\times(20-7.75)\times 7.16666\ldots+0.5\times 11.5\times(20-11.3333\ldots)$ ***(A1)***

$93.7291\ldots$ (sq. units)

94 (sq. units) ***A1***

Note: Answer must be given as a whole number to award final ***A1***.
Award ***(A1)(A1)(M1)(A1)A0*** for an answer of 93.7 without working.

METHOD 2: Dividing vertically into triangle and trapezoid

$(0.5\times 20+1.5=)\ 11.5$ seen in an area calculation ***(A1)***

attempt to substitute into area of trapezoid formula ***(M1)***
$(A=)\ 0.5\times(7.16666\ldots+11.5)\times(20-11.3333\ldots)$

Note: Lengths of parallel sides must be seen to award the ***M1***.

correct calculation of right triangle area ***(A1)***
$(A=)\ 0.5\times(11.3333\ldots-7.75)\times 7.16666\ldots$

$(A=)\ 0.5\times(11.3333\ldots-7.75)\times 7.16666\ldots+0.5\times(7.16666\ldots+11.5)\times(20-11.3333\ldots)$ ***(A1)***

$93.7291\ldots$ (sq. units)

94 (sq. units) ***A1***

Note: Answer must be given as a whole number to award final ***A1***.
Award ***(A1)(M1)(A1)(A1)A0*** for an answer of 93.7 without working.

METHOD 3: Dividing horizontally into triangle and trapezoid

$(0.5\times 20+1.5=)\ 11.5$ seen in an area calculation ***(A1)***

attempt to substitute into area of trapezoid formula ***(M1)***

$(A=)\ 0.5\times\left[(20-7.75)+(20-11.3333\ldots)\right]\times 7.16666\ldots$

Note: Lengths of parallel sides must be seen to award the ***M1***.

correct calculation of right triangle area ***(A1)***

$(A=)\ 0.5\times(20-11.3333\ldots)\times(11.5-7.16666\ldots)$

$(A=)\ 0.5\times(20-11.3333\ldots)\times(11.5-7.16666\ldots)+0.5\times[(20-7.75)+(20-11.3333\ldots)]\times 7.16666\ldots$ ***(A1)***

$93.7291\ldots$ (sq. units)

94 (sq. units) ***A1***

Note: Answer must be given as a whole number to award final ***A1***.
Award ***(A1)(M1)(A1)(A1)A0*** for an answer of 93.7 without working.

METHOD 4: Dividing into two triangles and rectangle

$(0.5\times 20+1.5=)11.5$ seen in an area calculation ***(A1)***

$(20-11.3333...)$ **OR** $(11.3333...-7.75)$ **OR** $(11.5-7.16666...)$ seen ***(A1)***

substitution into triangle area formula. ***(M1)***

$0.5\times(11.3333...-7.75)\times 7.16666...+(20-11.3333...)\times 7.16666...+$
$+0.5\times(11.5-7.16666...)\times(20-11.3333...)$

(A1)

$93.7291\ldots$ (sq. units))

94 (sq. units) ***A1***

Note: Answer must be given as a whole number to award final ***A1***.
Award ***(A1)(A1)(M1)(A1)A0*** for an answer of 93.7 without working.

METHOD 5: Calculus

A and C mid point $(13, 10.5)$

(gradient of AC=) $\frac{13-8}{8-18} = -\frac{5}{10}$

(gradient of $\perp$=) 2

AC bisector $2(x-13) = y-10.5$ **OR** $y = 2x-15.5$ ***A1***

attempt to integrate their equation and given equation ***(M1)***

$\text{area} = \int_{7.75}^{11.\dot{3}} 2x-15.5\,\mathrm{d}x + \int_{11.\dot{3}}^{20} 0.5x+1.5\,\mathrm{d}x$ ***(A1)(A1)***

Note: Award ***A1*** for each correct expression with correct limits.

93.7291… (sq. units))

94 (sq. units) ***A1***

Note: Answer must be given as a whole number to award final ***A1***.
Award ***A1(M1)(A1)(A1)A0*** for an answer of 93.7 without working.

(ii) (1 sq unit = 2.5 km $\times$ 2.5 km =) 6.25 (km^2) ***(A1)***

Note: Award ***A1*** for 6.25 seen.

$(94 \times 6.25\,\text{km}^2)$

588 (587.5) (km^2) ***A1***

Note: Accept: 586 $(585.807\ldots)$ (km^2) from $(93.7291\ldots \times 6.25$ km$^2)$.

[7 marks]
[Total: 19 marks]