

Markscheme

May 2026

**Mathematics: applications and
interpretation**

Standard level

Paper 1

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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) radius = 6547 (6371 + 176) seen anywhere **A1**
 attempt to find the circumference **(M1)**
 $C = 2\pi(6547)(= 41136.0142... = 13094\pi)$
 their circumference multiplied by 6
 distance = 246816.085... **A1**

Note: To award the **A1** their answer must round to the correct 3 sig figs. For example, if using an approximation for $\pi = 3.14$, distance = 246690.96

Award **A1** for the 3 sf answer of 247 000, provided it is supported by correct working.

$$\text{distance} = 2.47 \times 10^5 \text{ km}$$

AG
[3 marks]
(M1)

- (b) attempt to substitute into percentage error formula

$$\left| \frac{246816.085... - 231718}{231718} \right| \times 100\%$$

$$6.52\% \quad (6.51571...)$$

A1
[2 marks]

Note: Accept 6.60% (6.59508...) and 6.6% if using 2.47×10^5 .

Award at most **(M1)A0FT** if they use their incorrect answer from part (a).

Award **(M1)A0** for an unsupported answer of 6.59%.

Total [5 marks]

2 (a) (i) $r = 2$

A1

Note: Award **A1** if $\times 2$ is seen as the common ratio.

(ii) use of formula for n th term of geometric sequence or list of terms

(M1)

$$u_5 = u_1 2^4 = 48 \text{ OR } u_6 = u_1 2^5 = 96 \text{ OR } 3, 6, 12, 24, 48, 96 \dots$$

$$u_1 = 3$$

A1

[3 marks]

(b) attempt to use the geometric series formula with their values from (a)

(M1)

$$S_{15} = \frac{3(2^{15} - 1)}{2 - 1}$$

$$= 98301 \text{ OR } 98300$$

A1

[2 marks]

Total [5 marks]

3 (a) (i) H_0 : favourite genre of book is independent of age A1

Note: Accept 'not associated' and 'not dependent' in place of independent but do not accept 'not correlated' or 'not related'.

(ii) H_1 : favourite genre of book is not independent of age A1

Note: Accept 'associated' and 'dependent' in place of 'not independent' but do not accept 'correlated' or 'related' unless already penalised in part (i).

Note: Award **A0A1** if hypotheses are reversed.

[2 marks]

(b) p – value = 0.0336(0.0336233...) A2

Note: Award **A1A0** for 0.034 .

[2 marks]

(c) $0.0336 < 0.05$ R1

(reject H_0 so) favourite genre of book is not independent of age A1

Note: Do not award **R0A1**. Accept $p < \text{sig level}$ provided their p -value is seen.

[2 marks]

(d) (i) convenience sampling A1

Note: Accept opportunity sampling or accidental sampling as equivalent terms.
Do not penalize spelling errors (e.g convenience)

(ii) sample is not randomly selected (everyone does not have an equal chance of being selected) R1

OR

sample may not be representative of the school population R1

OR

choice of people in sample may not be independent R1

OR

convenience sampling is biased R1

Note: Accept any valid reason which mentions the sampling method, not just the survey eg 'have a greater choice of book genres' is not valid.

[2 marks]

Total [8 marks]

- 4 (a) recognition of binomial distribution (i.e. $X \sim B(12, 0.73)$ where X is the number of heads) **(M1)**
 0.212(0.212150...) **A1**

[2 marks]

- (b) **METHOD 1**

recognition of cumulative binomial distribution **(M1)**

$$P(X \geq 7) \text{ OR } 1 - P(X \leq 6) \text{ OR } P(X > 6)$$

$$0.924(0.923951\dots)$$

A1

METHOD 2

recognition of cumulative binomial distribution (i.e. $T \sim B(12, 0.27)$) **(M1)**

where T represents the number of tails

$$P(T \leq 5)$$

$$0.924(0.923951\dots)$$

A1

[2 marks]

- (c) attempt to find expected value using their (b) multiplied by 49 **(M1)**
 45.3(45.2736...) **A1**

Note: Accept 45.

[2 marks]

Total [6 marks]

5 (a) METHOD 1

splitting up garden into two rectangles

(M1)

$$A = 6x(x+4) + 2x(x+6) \text{ OR } A = (6x^2 + 24x) + (2x^2 + 12x)$$

A1A1

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

$$A = 8x^2 + 36x$$

AG

METHOD 2

splitting up garden into two rectangles

(M1)

$$A = 2x(2x+10) + 4x(x+4) \text{ OR } A = (4x^2 + 20x) + (4x^2 + 16x)$$

A1A1

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

$$A = 8x^2 + 36x$$

AG

METHOD 3

subtracting two rectangles

(M1)

$$A = 6x(2x+10) - 4x(x+6) \text{ OR } A = (12x^2 + 60x) - (4x^2 + 24x)$$

A1A1

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

$$A = 8x^2 + 36x$$

AG

[3 marks]

(b) attempt to solve $8x^2 + 36x = 72$ OR $8x^2 + 36x - 72 = 0$

(M1)

$$x = 1.5 \quad (x = -6 \text{ is rejected})$$

A1

Note: Award **(M1)A0** if $x = -6$ is also given as a solution.

[2 marks]

(c) attempt to add the four sides $x+4, 6x, 2x+10$ and $2x$ with or without substituting their value for x

(M1)

$$\text{fencing needed} = 11(1.5) + 14 \text{ OR } 5.5 + 9 + 13 + 3$$

$$30.5 \text{ m}$$

A1

[2 marks]

Total [7 marks]

6 (a)

	Lost	Not lost	Totals
Heavy	2	22	24
Not heavy	3	53	56
Totals	5	75	80

A2

Note: Award **A1** for one row or column correct (as well as the totals row), **A2** for completely correct.

[2 marks]

(b) (i) $\frac{56}{80} \left(\frac{7}{10}, 0.7 \right)$

A1

(ii) $\frac{2}{24} \left(\frac{1}{12}, 0.0833333... \right)$

A1

[2 marks]

(c) let X be the weight of the bag

$$P(\text{Heavy}) = P(X > 18) = 0.252(0.252492...)$$

A1

attempt to multiply two probabilities, one of which must be their $P(X > 18)$

(M1)

$$P(\text{Heavy and lost}) = 0.252492... \times \frac{1}{12}$$

$$= 0.0210(0.0210410...)$$

A1

[3 marks]

Total [7 marks]

- 7 (a) attempt to substitute into the trapezoidal rule formula (M1)

$$\left(\int_0^3 y \, dx \approx\right) \frac{1}{2}(0.6)(15+21+2(18+18+17+18))$$

$$53.4 \text{ m}^2$$

A1

[2 marks]

- (b) attempt to find definite integral (M1)

$$\int_0^3 (1.37x^3 - 6.07x^2 + 7.87x + 15) \, dx$$

Note: Condone the absence of or incorrect limits for the (M1).

$$53.5275$$

A1

$$53.5275 > 53.4$$

R1AG

[3 marks]

- (c) attempt to find the total length or number of rolls needed (M1)

$$\frac{53.5275}{0.6} = 89.2125$$

$$\frac{89.2125}{1.4} = 63.7232\dots$$

so 64 rolls needed

(A1)

attempt to find cost

(M1)

$$\text{cost} = 64 \times 12.50 + 28$$

Note: Award (M1) for multiplying their number of rolls by 12.50 and adding 28 even if their number of rolls is unrounded. This M mark may be awarded independently of the previous M mark.

$$\text{cost} = \$828$$

A1

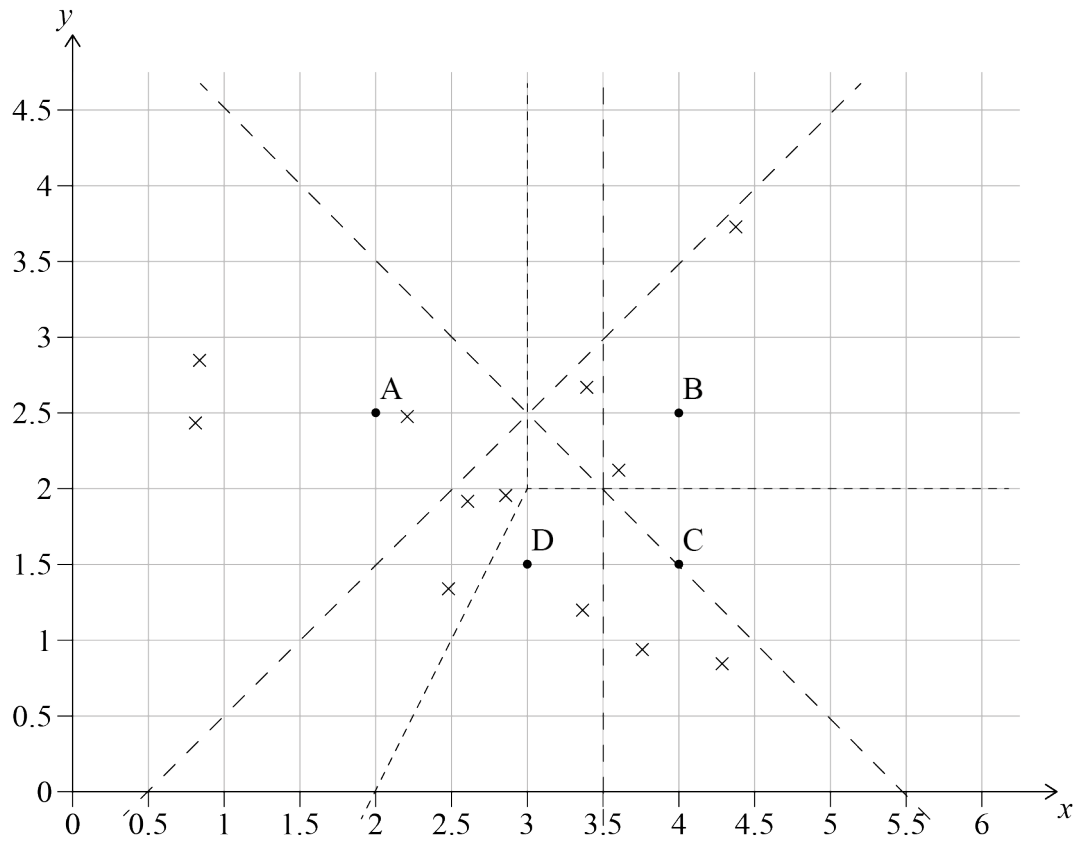
Note: Do not award final A1 for answers resulting from use of decimal values in cost calculation (number of rolls must be a whole number).

Note: For candidates who use the lengths given in the table to find no of rolls equal to 67 and cost \$865.50 (\$866), award (M1)(A0)(M1)A1FT.

[4 marks]

Total [9 marks]

8 (a)



A1 for perpendicular bisector of $[DC]$.

A1 for perpendicular bisector of $[AD]$, passing through $(0.5, 0)$ and $(2.5, 2)$.

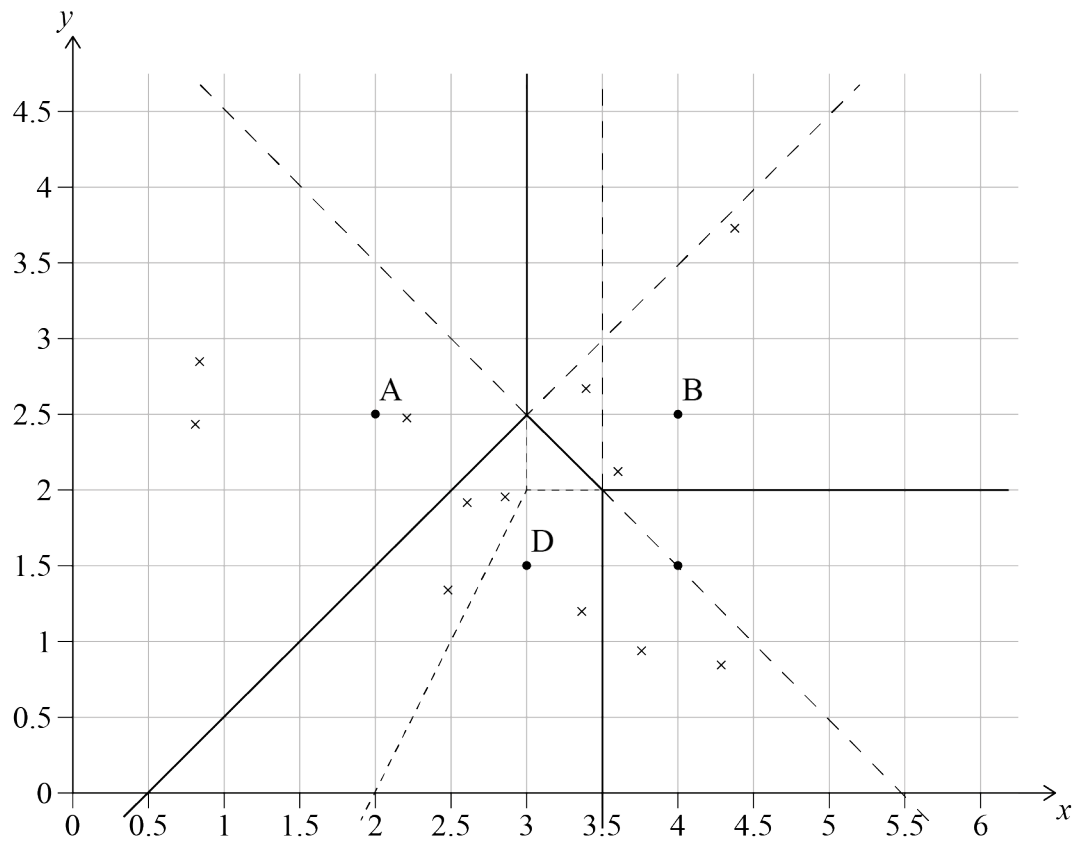
A1 for perpendicular bisector of $[BD]$, passing through $(5.5, 0)$ and $(3.5, 2)$.

[3 marks]

continued...

Question 8 continued

(b)



attempt at defining appropriate regions with at least two edges

M1

all edges correct sufficiently long to define the region

A1

[2 marks]

(c) Hotel D (which is closest to 4 of the attractions)

A1

[1 mark]

Total [6 marks]

- 9 (a) (i) $P'(5) = 0$ **A1**
- (ii) no growth (in the population of grasshoppers) **A1**
 OR
 the population (of grasshoppers) has reached its maximum **A1**
 OR
 the population (of grasshoppers) is in equilibrium **A1**
 (since it is neither increasing nor decreasing) **A1**
 OR
 the growth rate is zero **A1**
 OR
 the rate of change of the population (of grasshoppers) is zero **A1**
- [2 marks]**
- (b) attempt to integrate the function (i.e. at least two correct terms) **(M1)**
- $$P(t) = 70t + \frac{t^2}{2} - t^3 (+c)$$
- A1**
- attempt to find the value of c (i.e. setting *their* $P(t) = 254$) **(M1)**
- $$P(t) = 70t + \frac{t^2}{2} - t^3 + 16.5$$
- A1**
- [4 marks]**
- (c) setting their $P(t) = 0$ **(M1)**
- $t = 8.73246\dots$
- 8.73 weeks **A1**

Note: Award **(M1)A0** for an unsupported answer of 9 weeks.

Award **(M1)A0** for a final answer $-7.99615\dots$ or $-0.23630\dots$ seen

[2 marks]

Total [8 marks]

- 10 (a) attempt to substitute into formula

(M1)

$$M = -10.7 + \frac{2}{3} \log_{10} (2.1 \times 10^{30})$$

$$M = 9.51(9.51481\dots)$$

A1

Note: Accept 9.5 since normal convention for earthquake magnitudes is 1dp.

[2 marks]

- (b) setting equation = 7.5 and attempting to solve for S

(M1)

$$7.5 = -10.7 + \frac{2}{3} \log_{10} (S)$$

$$S = 2.00 \times 10^{27} (1.99526\dots \times 10^{27})$$

A1

Note: Accept 2×10^{27} .

[2 marks]

- (c) attempt to find k

(M1)

$$k = \frac{2.1 \times 10^{30}}{1.99526\dots \times 10^{27}}$$

$$k = 1050 (1052.49\dots)$$

A1

[2 marks]

Total [6 marks]

- 11 (a) (i) 1 A1
- (ii) $-x$ A1

[2 marks]

- (b) attempt to use the expectation formula (M1)

$$E(Y) = \frac{1+3+4+5+6-x}{6} \left(= \frac{19-x}{6} \right) \quad \text{A1}$$

Note: Do not allow follow through if their value of b is not a function of x . **M1** can still be awarded for an attempt at using the expectation formula.

[2 marks]

- (c) $x = 20$ A1

[1 mark]

Total [5 marks]

12 (a) 15 m

A1
[1 mark]

(b) **METHOD 1 – Finding distance from A to Helicopter (H)**

angle of 14° seen

A1

use of sine rule to find AH

(M1)

$$\frac{AH}{\sin 122^\circ} = \frac{15}{\sin 14^\circ}$$

$$AH = 52.5819...$$

A1

attempt to find distance between A and top of building (C)

(M1)

$$\cos 44^\circ = \frac{AC}{52.5819...}$$

$$AC = 37.8242...$$

A1

attempt to find number of floors

(M1)

$$\frac{37.8242...}{3.75} + 18$$

28 floors

A1

Note: If value has not been rounded to nearest whole number do not award final **A1**.

METHOD 2 – Finding distance from B to Helicopter (H)

angle of 14° seen

A1

use of sine rule to find distance BH

(M1)

$$\frac{BH}{\sin 44^\circ} = \frac{15}{\sin 14^\circ}$$

$$BH = 43.0712...$$

A1

attempt to find distance between B and top of building (C)

(M1)

$$\cos 58^\circ = \frac{BC}{43.0712...}$$

$$BC = 22.8242...$$

A1

attempt to find number of floors

(M1)

$$\frac{22.8242...}{3.75} + 22$$

28 floors

A1

Note: If value has not been rounded to nearest whole number do not award final **A1**.

continued...

Question 12 continued

METHOD 3 – method 2 with reference to floors

angle of 14° seen **A1**

use of sine rule to find distance BH **(M1)**

$$\frac{BH}{\sin 44^\circ} = \frac{4}{\sin 14^\circ}$$

BH = 11.4856... **A1**

attempt to find no of floors between B and top of building (C) **(M1)**

$$\cos 58^\circ = \frac{BC}{11.4856...}$$

BC = 6 (= 6.08647...) **A1**

attempt to find number of floors **(M1)**

$$6 + 22$$

28 floors **A1**

Note: If value has not been rounded to nearest whole number do not award final **A1**.

METHOD 4 – finding distance between C and H

attempt to find distance CH **(M1)**

$$\begin{aligned} CH &= \frac{15}{\tan 46^\circ - \tan 32^\circ} \\ &= 36.5264... \end{aligned}$$

A1

attempt to find BH **(M1)**

$$\begin{aligned} BH &= \frac{36.5264...}{\cos 32^\circ} \\ &= 43.0712... \end{aligned}$$

A1

finding vertical height from B to C

$$43.0712... \times \sin 32^\circ \text{ OR } 36.5264... \times \tan 32^\circ (= 22.8242...) \quad \textbf{A1}$$

continued...

Question 12 continued

attempt to find number of floors

(M1)

$$\frac{22.8242...}{3.75} + 22 (= 28.0864...)$$

28 floors

A1

Note: If value has not been rounded to nearest whole number do not award final **A1**.

Note: If candidates do method 1 with reference to floors AH = 14.0218...and
AC = 10.0864....

Note: If candidates have 18.75 or 5 floors for part (a) award full follow through marks for 31 floors (30.6080...).

For an unsupported final answer of 28, award **A0(M1)A0(M1)A0(M1)A1**.

[7 marks]

Total [8 marks]