



MARKSCHEME

May 2014

MATHEMATICAL STUDIES

Standard Level

Paper 2

**Paper 2 Markscheme
Instructions to Examiners**

Notes: If in doubt about these instructions or any other marking issues, contact your team leader for clarification.

1 Abbreviations

M Marks awarded for **Method**

A Marks awarded for an **Answer** or for **Accuracy**

R Marks awarded for clear **Reasoning**

G Marks awarded for correct solutions obtained from a **Graphic Display Calculator**, when no working shown.

AG **Answer Given** in the question and consequently, marks not awarded.

ft Marks that can be awarded as **follow through** from previous results in the question.

2 Method of Marking

- (a) All marking must be done in scoris using the mathematical studies annotations and in accordance with the current document for guidance in e-marking Mathematical Studies SL. It is essential that you read this document before you start marking.
- (b) If a question part is completely correct use the number tick annotations to award full marks. If a part is completely wrong use the **A0** annotation, otherwise full annotations must be shown.
- (c) Working crossed out by the candidate should not be awarded any marks.
- (d) Where candidates have written two solutions to a question, only the first solution should be marked.
- (e) If correct working results in a correct answer but then further working is developed, full marks may **not** always be awarded. Full marks **will** be awarded if the candidate shows correct working leading to the correct answer. See also section 4(c).

Example: Calculate the gradient of the line passing through the points (5, 3) and (0, 9).

Markscheme	Candidates' Scripts	Marking
$\frac{9-3}{0-5} \quad (M1)$ <p>Award (M1) for correct substitution in gradient formula</p> $= -\frac{6}{5} \quad (A1)$	(i) $\frac{9-3}{0-5} = -\frac{6}{5}$ <p>Gradient is $= -\frac{6}{5}$</p> <p>(There is clear understanding of the gradient.)</p> $y = -\frac{6}{5}x + 9$	<p>(M1)</p> <p>(A1)</p>
	(ii) $\frac{9-3}{0-5} = -\frac{6}{5}$ $y = -\frac{6}{5}x + 9$ <p>(There is confusion about what is required.)</p>	<p>(M1)</p> <p>(A0)</p>

3 Follow-through (ft) Marks

Errors made at any step of a solution affect all working that follows. To limit the severity of the penalty, **follow through (ft)** marks can be awarded. Mark schemes will indicate where it is appropriate to apply follow through in a question with **‘(ft)’**.

- (a) Follow through applies only from one part of a question to a subsequent part of the question. Follow through does not apply within the same part.
- (b) If an answer resulting from follow through is extremely unrealistic (eg, negative distances or incorrect by large order of magnitude) then the final **A** mark should not be awarded.
- (c) If a question is transformed by an error into a **different, much simpler question** then follow through may not apply.
- (d) To award follow through marks for a question part, **there must be working present for that part**. An isolated follow through answer, without working is regarded as incorrect and receives no marks **even if it is approximately correct**.
- (e) The exception to the above would be in a question which is testing the candidate’s use of the GDC, where working will not be expected. **The markscheme will clearly indicate where this applies**.
- (f) Inadvertent use of radians will be penalised the first time it occurs. The markscheme will give clear instructions to ensure that only one mark per paper can be lost for the use of radians.

Example: Finding angles and lengths using trigonometry

Markscheme	Candidates’ Scripts	Marking
<p>(a) $\frac{\sin A}{3} = \frac{\sin 30}{4}$ (MI)(AI)</p> <p><i>Award (MI) for substitution in sine rule formula, (AI) for correct substitutions.</i></p> <p>$A = 22.0^\circ$ (22.0243...) (AI)(G2)</p>	<p>(a) $\frac{\sin A}{4} = \frac{\sin 30}{3}$</p> <p>$A = 41.8^\circ$</p> <p><i>(Note: the 2nd (AI) here was not marked (ft) and cannot be awarded because there was an earlier error in the same question part.)</i></p>	<p>(MI)(A0)</p> <p><i>(use of sine rule but with wrong values)</i></p> <p>(A0)</p>
<p>(b) $x = 7 \tan (22.0243\dots^\circ)$ (MI)</p> <p>$= 2.83$ (2.83163...) (AI)(ft)</p>	<p>(b) case (i) $x = 7 \tan 41.8^\circ$</p> <p>$= 6.26$</p> <p>but case (ii) 6.26</p>	<p>(MI)</p> <p>(AI)(ft)</p> <p>(G0)</p> <p><i>since no working shown</i></p>

4 Using the Markscheme

- (a) **A** marks are **dependent** on the preceding **M** mark being awarded, it is **not** possible to award **(M0)(A1)**. Once an **(M0)** has been awarded, all subsequent **A** marks are lost in that part of the question, even if calculations are performed correctly, until the next **M** mark.
The only exception to this will be for an answer where the accuracy is specified in the question – see section 5.
- (b) **A** marks are **dependent** on the **R** mark being awarded, it is **not** possible to award **(A1)(R0)**. Hence the **(A1)** cannot be awarded for an answer which is correct when no reason or the wrong reason is given.
- (c) In paper 2 candidates are expected to demonstrate their ability to communicate mathematics using appropriate working. Answers which are correct but not supported by adequate working will **not always receive full marks**, these unsupported answers are designated **G** in the mark scheme as an alternative to the full marks. Example **(M1)(A1)(A1)(G2)**.

Example: Using trigonometry to calculate an angle in a triangle.

Markscheme	Candidates' Scripts	Marking
<p>(a) $\frac{\sin A}{3} = \frac{\sin 30}{4}$ (M1)(A1) Award (M1) for substitution in sine rule formula, (A1) for correct substitutions. $A = 22.0^\circ$ (22.0243...) (A1)(G2)</p>	<p>(i) $\frac{\sin A}{3} = \frac{\sin 30}{4}$ $A = 22.0^\circ$</p> <p>(ii) $A = 22.0^\circ$ (G2) <i>Note: G marks are used only if no working has been shown and the answer is correct.</i></p>	<p>(M1)(A1) (A1)</p>

- (d) **Alternative methods** may not always be included. Thus, if an answer is wrong then the working must be carefully analysed in order that marks are awarded for a different method consistent with the markscheme.
Where alternative methods for complete questions are included in the markscheme, they are indicated by '**OR**' etc.

- (e) Unless the question specifies otherwise, accept **equivalent forms**. For example: $\frac{\sin \theta}{\cos \theta}$ for $\tan \theta$.

On the markscheme, these equivalent numerical or algebraic forms will sometimes be written in brackets after the required answer.

Where numerical answers are required as the final answer to a part of a question in the markscheme, the scheme will show, in order:

- the 3 significant figure answer worked through from full calculator display;
- the exact value (for example $\sqrt{3}$ if applicable);
- the full calculator display in the form 2.83163... as in the example above.

Where answers are given to 3 significant figures and are then used in subsequent parts of the question leading to a **different 3** significant figure answer, these solutions will also be given.

- (f) As this is an international examination, all valid **alternative forms of notation** should be accepted. Some examples of these are:

Decimal points: 1.7; 1'7; 1·7; 1,7 .

Different descriptions of an interval: $3 < x < 5$; $(3, 5)$; $] 3, 5 [$.

Different forms of notation for set properties (eg, complement): A' ; \bar{A} ; A^c ; $U - A$; $(A; U \setminus A$.

Different forms of logic notation: $\neg p$; p' ; \tilde{p} ; \bar{p} ; $\sim p$.

$$p \Rightarrow q; p \rightarrow q; q \Leftarrow p .$$

- (g) Discretionary marks: There will be very rare occasions where the markscheme does not cover the work seen. In such cases the annotation DM should be used to indicate where an examiner has used discretion. Discretion should be used sparingly and if there is doubt and exception should be raised through scoris to the team leader.

As with previous sessions there will be no whole paper penalty marks for accuracy AP, financial accuracy FP and units UP. Instead these skills will be assessed in particular questions and the marks applied according to the rules given in sections 5, 6 and 7 below.

5 Accuracy of Answers

Incorrect accuracy should be penalized once only in each question according to the rules below.

Unless otherwise stated in the question, all numerical answers should be given exactly or correct to 3 significant figures.

1. If the candidate's unrounded answer is seen and would round to the required 3 sf answer, then award *(AI)* and ignore subsequent rounding.
2. If the candidate's unrounded answer is **not** seen then award *(AI)* if the answer given is **correctly** rounded to 2 or more significant figures, otherwise *(A0)*.
Note: If the candidate's unrounded answer is **not** seen and the answer is given correct to 1 sf (correct or not), the answer will be considered wrong and will not count as incorrect accuracy. If this answer is used in subsequent parts, then working must be shown for further marks to be awarded.
3. If a correct 2 sf answer is used in subsequent parts, then working **must** be shown for further marks to be awarded. (This treatment is the same as for following through from an incorrect answer.)

These 3 points (see numbers in superscript) have been summarized in the table below and illustrated in the examples following.

	If candidates final answer is given ...				
	Exact or correct to 3 or more sf	Incorrect to 3 sf	Correct to 2 sf ³	Incorrect to 2 sf	Correct or incorrect to 1 sf
Unrounded answer seen ¹	Award the final <i>(AI)</i> irrespective of correct or incorrect rounding				
Unrounded answer not seen ²	<i>(AI)</i>	<i>(A0)</i>	<i>(AI)</i>	<i>(A0)</i>	<i>(A0)</i>
Treatment of subsequent parts	As per MS	Treat as follow through, only if working is seen ³			

Examples:

Markscheme	Candidates' Scripts	Marking
9.43 (9.43398...) (AI)	(i) 9.43398... is seen followed by 9; 9.4; 9.43; 9.434 <i>etc.</i> (correctly rounded)	(AI)
	(ii) 9.43398... is seen followed by 9.433; 9.44 <i>etc.</i> (incorrectly rounded)	(AI)
	(iii) 9.4	(AI)
	(iv) 9	(A0) (correct to 1 sf)
	(v) 9.3	(A0) (incorrectly rounded to 2 sf)
	(vi) 9.44	(A0) (incorrectly rounded to 3 sf)

Markscheme	Candidates' Scripts	Marking
7.44 (7.43798...) (AI)	(i) 7.43798... is seen followed by 7; 7.4; 7.44; 7.438 <i>etc.</i> (correctly rounded)	(AI)
	(ii) 7.43798... is seen followed by 7.437; 7.43 <i>etc.</i> (incorrectly rounded)	(AI)
	(iii) 7.4	(AI)
	(iv) 7	(A0) (correct to 1 sf)
	(v) 7.5	(A0) (incorrectly rounded to 2 sf)
	(vi) 7.43	(A0) (incorrectly rounded to 3 sf)

Example: ABC is a right angled triangle with angle $ABC = 90^\circ$, $AC = 32$ cm and $AB = 30$ cm. Find (a) the length of BC, (b) The area of triangle ABC.

Markscheme	Candidates' Scripts	Marking
(a) $BC = \sqrt{32^2 - 30^2}$ (MI) Award (MI) for correct substitution in Pythagoras' formula $= 11.1 (\sqrt{124}, 11.1355\dots)$ (AI)	(a) $BC = \sqrt{32^2 - 30^2}$ (MI) 11 (cm) (AI) (2 sf answer only seen, but correct)	
(b) $\text{Area} = \frac{1}{2} \times 30 \times 11.1355\dots$ (MI) Award (MI) for correct substitution in area of triangle formula $= 167(167.032\dots)$ (AI)(ft)	(b) case (i) $\text{Area} = \frac{1}{2} \times 30 \times 11$ (MI) (working shown) $= 165 \text{ (cm}^2\text{)}$ (AI)(ft) case (ii) $= 165 \text{ (cm}^2\text{)}$ (M0)(A0)(ft) (No working shown, the answer 11 is treated as a ft, so no marks awarded here)	

Certain answers obtained from the GDC are worth 2 marks and working will not be seen. In these cases only one mark should be lost for accuracy.

eg, Chi-squared, correlation coefficient, mean

Markscheme	Candidates' Scripts	Marking
Chi-squared 7.68 (7.67543...) (A2)	(a) 7.7 (G2) (b) 7.67 (G1) (c) 7.6 (G1) (d) 8 (G0) (e) 7 (G0) (e) 7.66 (G0)	

Regression line

Markscheme	Candidates' Scripts	Marking
$y = 0.888x + 13.5$ (A2) ($y = 0.887686\dots x + 13.4895\dots$) If an answer is not in the form of an equation award at most (A1)(A0).	(a) $y = 0.89x + 13$	(G2) (both accepted)
	(b) $y = 0.88x + 13$	(G1) (one rounding error)
	(c) $y = 0.88x + 14$	(G1) (rounding error repeated)
	(d) (i) $y = 0.9x + 13$	(G1) (1 sf not accepted)
	(ii) $y = 0.8x + 13$	
(e) $0.88x + 13$ (G0)	(one rounding error and not an equation)	

Maximum/minimum/points of intersection

Markscheme	Candidates' Scripts	Marking
(2.06, 4.49) (A1)(A1) (2.06020..., 4.49253...)	(a) (2.1, 4.5) (A1)(A1)	(both accepted)
	(b) (2.0, 4.4) (A1)	(same rounding error twice)
	(c) (2.06, 4.4) (A1)	(one rounding error)
	(d) (2, 4.4) (A0)	(1sf not accepted, one rounding error)

Rounding of an exact answer to 3 significant figures **should be accepted if performed correctly**.

Exact answers such as $\frac{1}{4}$ can be written as decimals to fewer than 3 significant figures if the result is still exact. Reduction of a fraction to its lowest terms is **not** essential, however where an answer simplifies to an integer this is expected.

Ratios of π and answers taking the form of square roots of integers or any rational power of an integer (eg, $\sqrt{13}, 2^{\frac{2}{3}}, \sqrt[4]{5}$.) may be accepted as exact answers. All other powers (eg, of non-integers) and values of transcendental functions such as sine and cosine must be evaluated.

If the level of accuracy is specified in the question, a mark will be allocated for giving the answer to the required accuracy. In all such cases the final mark is not awarded if the rounding does not follow the instructions given in the question. A mark for specified accuracy can be regarded as a (ft) mark regardless of an immediately preceding (M0).

6 Level of accuracy in finance questions

The accuracy level required for answers will be specified in all questions involving money. This will usually be either whole units or two decimal places. The first answer not given to the specified level of accuracy will not be awarded the final **A** mark. The markscheme will give clear instructions to ensure that only one mark per paper can be lost for incorrect accuracy in a financial question.

Example: A financial question demands accuracy correct to 2 dp.

Markscheme	Candidates' Scripts	Marking
\$231.62 (231.6189) (AI)	(i) 231.6 (A0) (ii) 232 (A0) (iii) 231.61 (A0) (iv) 232.00 (A0)	(Correct rounding to incorrect level) (Parts (iii) and (iv) are both incorrect rounding to correct level)

7 Units in answers

There will be specific questions for which the units are required and this will be indicated clearly in the markscheme. The first correct answer with no units or incorrect units will not be awarded the final **A** mark. The markscheme will give clear instructions to ensure that only one or two marks per paper can be lost for lack of units or incorrect units.

The units are considered only when the numerical answer is awarded (AI) under the accuracy rules given in Section 5.

Example:

Markscheme	Candidates' Scripts	Marking
(a) 37000 m ² (AI)	(a) 36000 m ² (A0)	(Incorrect answer so units not considered)
(b) 3200 m ³ (AI)	(b) 3200 m ² (A0)	(Incorrect units)

If no method is shown and the answer is correct but with incorrect or missing units award G marks with a one mark penalty.

8 Graphic Display Calculators

Candidates will often be obtaining solutions directly from their calculators. They must use mathematical notation, not calculator notation. No method marks can be awarded for incorrect answers supported only by calculator notation. The comment 'I used my GDC' cannot receive a method mark.

1. (a) (i) $0.7 \left(\frac{70}{100}, \frac{7}{10}, 70\% \right)$ (AI)

(ii) $0.2 \left(\frac{20}{100}, \frac{2}{10}, \frac{1}{5}, 20\% \right)$ (AI)

(iii) $0.85 \left(\frac{85}{100}, \frac{17}{20}, 85\% \right)$ (AI) [3 marks]

(b) (i) 0.7×0.85 (MI)

Note: Award (MI) for multiplying their values from parts (a)(i) and (a)(iii).

$= 0.595 \left(\frac{119}{200}, 59.5\% \right)$ (AI)(ft)(G1)

Note: Follow through from part (a).

(ii) $0.3 \times 0.2 + 0.7 \times 0.85$ (MI)(MI)

Note: Award (MI) for their two products, (MI) for adding their two products.

$= 0.655 \left(\frac{131}{200}, 65.5\% \right)$ (AI)(ft)(G2)

Note: Follow through from part (a).

(iii) $\frac{0.595}{0.655}$ (AI)(ft)(AI)(ft)

Notes: Award (AI)(ft) for correct numerator, (AI)(ft) for correct denominator. Follow through from parts (b)(i) and (ii).

$= 0.908 \left(0.90839\dots, \frac{119}{131}, 90.8\% \right)$ (AI)(ft)(G2) [8 marks]

(c) 0.3×0.3 (MI)

$= 0.09 \left(\frac{9}{100}, 9\% \right)$ (AI)(G2) [2 marks]

continued...

Question 1 continued

- (d) 0.3×0.7 *(M1)*
 $0.3 \times 0.7 \times 2$ **OR** $(0.3 \times 0.7) + (0.7 \times 0.3)$ *(M1)*

Note: Award *(M1)* for their correct product seen, *(M1)* for multiplying their product by 2 or for adding their products twice.

$$= 0.42 \left(\frac{42}{100}, \frac{21}{50}, 42\% \right) \quad (A1)(ft)(G2) \quad [3 \text{ marks}]$$

Note: Follow through from part (a)(i).

Total [16 marks]

2. (a) 3.8×320 (AI)

Note: Award (AI) for 320 or equivalent seen.

$= 1216$ (AI)
 $= 1220$ (m) (AG) [2 marks]

Note: Both unrounded and rounded answer must be seen for the final (AI) to be awarded.

- (b) $\frac{850}{303}$ (ms⁻¹) (2.81, 2.80528...) (AI)(GI) [1 mark]

- (c) $AC^2 = 1220^2 + 850^2 - 2(1220)(850)\cos 110^\circ$ (MI)(AI)

Note: Award (MI) for substitution into cosine rule formula, (AI) for correct substitutions.

$AC = 1710$ (m) (1708.87...) (AI)(G2) [3 marks]

Notes: Accept 1705 (1705.33...).

- (d) $1220 + 850 + 1708.87...$ (MI)
 $= 3780$ (m) (3778.87...) (AI)(ft)(GI) [2 marks]

Notes: Award (MI) for adding the three sides. Follow through from their answer to part (c). Accept 3771 (3771.33...).

continued...

Question 2 continued

(e) $\frac{\sin C}{1220} = \frac{\sin 110^\circ}{1708.87\dots}$ **(M1)(A1)(ft)**

Notes: Award **(M1)** for substitution into sine rule formula, **(A1)(ft)** for correct substitutions. Follow through from their part (c).

$C = 42.1^\circ (42.1339\dots)$ **(A1)(ft)(G2)**

Notes: Accept 41.9° , 42.0° , 42.2° , 42.3° .

OR

$\cos C = \frac{1708.87\dots^2 + 850^2 - 1220^2}{2 \times 1708.87\dots \times 850}$ **(M1)(A1)(ft)**

Notes: Award **(M1)** for substitution into cosine rule formula, **(A1)(ft)** for correct substitutions. Follow through from their part (c).

$C = 42.1^\circ (42.1339\dots)$ **(A1)(ft)(G2)** [3 marks]

Notes: Accept 41.2° , 41.8° , 42.4° .

continued...

Question 2 continued

(f) $\frac{1}{2} \times 1220 \times 850 \times \sin 110^\circ$ (MI)(AI)(ft)

OR

$\frac{1}{2} \times 1708.87... \times 850 \times \sin 42.1339...^\circ$ (MI)(AI)(ft)

OR

$\frac{1}{2} \times 1220 \times 1708.87... \times \sin 27.8661...^\circ$ (MI)(AI)(ft)

Note: Award (MI) for substitution into area formula, (AI)(ft) for correct substitution.

$= 487000 \text{ m}^2$ (487230... m^2) (AI)(ft)(G2) [3 marks]

Notes: The answer is 487000 m^2 , **units are required.**
Accept 486000 m^2 ($485633... \text{ m}^2$).
If workings are not shown and units omitted, award (GI) for 487000 or 486000.
Follow through from parts (c) and (e).

Total [14 marks]

3. (a) 60 (AI) [1 mark]
 (b) 12.5 (AI) [1 mark]
 (c) $\frac{3 \times 2.5 + 5 \times 7.5 + \dots + 10 \times 27.5}{60}$ (MI)

Note: Award (MI) for an attempt to substitute their mid-interval values (consistent with their answer to part (b)) into the formula for the mean. Award (MI) where a table is constructed with their (consistent) mid-interval values listed along with the frequencies.

$$= \frac{1075}{60} \left(\frac{215}{12}, 17.9, 17.9166\dots \right) \quad (AI)(ft)(G2) \quad [2 \text{ marks}]$$

Note: Follow through from their answer to part (b).

- (d) $a = 34, b = 60$ (AI)(AI) [2 marks]
 (e) (i) ≤ 21.25 minutes (AI)

Note: Accept 21.25.
 Accept any answer between 21 and 21.5.
 (Accept 21.5, but do not accept 21.)

- (ii) 5 (AI)

Note: Accept < 6 . Do not accept 6.
 Answer must be an integer.

- (iii) $60 - 45$ (MI)

$$= 15 \quad (AI)(G2) \quad [4 \text{ marks}]$$

Notes: Award (MI) for subtraction from 60. Accept 15 ± 1 .
 Answer must be an integer.

Total [10 marks]

4. *The first time an answer is not given to the nearest dollar in parts (a) to (e), the final (A1) in that part is not awarded.*

(a) 60×24 (M1)

Note: Award (M1) for correct product.

$= 1440$ (A1)(G2) [2 marks]

(b) (i) $10 + (17 - 1)(5)$ (M1)(A1)

Note: Award (M1) for substituted arithmetic sequence formula, (A1) for correct substitution.

$= 90$ (A1)(G2)

(ii) $\frac{24}{2}(2(10) + (24 - 1)(5))$ (M1)

OR

$\frac{24}{2}(10 + 125)$ (M1)

Note: Award (M1) for correct substitution in arithmetic series formula.

$= 1620$ (A1)(ft)(G1) [5 marks]

Note: Follow through from part (b)(i).

continued...

Question 4 continued

(c) (i) $15(1.1)^{12}$

(MI)(AI)

Note: Award (MI) for substituted geometric sequence formula, (AI) for correct substitutions.

= 47

(AI)(G2)

Note: Award (MI)(AI)(A0) for 47.08.
Award (GI) for 47.08 if workings are not shown.

(ii) $\frac{15(1.1^{24} - 1)}{1.1 - 1}$

(MI)

Note: Award (MI) for correct substitution in geometric series formula.

= 1327

(AI)(ft)(GI) [5 marks]

Note: Follow through from part (c)(i).

continued...

Question 4 continued

(d) $1500 \left(1 + \frac{6}{100(12)} \right)^{12(2)}$ **(MI)(AI)**

Note: Award **(MI)** for substituted compound interest formula, **(AI)** for correct substitutions.

OR

$N = 2$
 $I\% = 6$
 $PV = 1500$
 $P/Y = 1$
 $C/Y = 12$

(AI)(MI)

Note: Award **(AI)** for $C/Y = 12$ seen, **(MI)** for other correct entries.

OR

$N = 24$
 $I\% = 6$
 $PV = 1500$
 $P/Y = 12$
 $C/Y = 12$

(AI)(MI)

Note: Award **(AI)** for $C/Y = 12$ seen, **(MI)** for other correct entries.

$= 1691$ **(AI)(G2)** [3 marks]

(e) Option D **(AI)(ft)** [1 mark]

Note: Follow through from their parts (a), (b), (c) and (d). Award **(AI)(ft)** only if values for the four options are seen and only if their answer is consistent with their parts (a), (b), (c) and (d).

continued...

Question 4 continued

(f) $1750 = 1500 \left(1 + \frac{r}{100} \right)^2$ **(MI)(AI)**

Note: Award **(MI)** for substituted compound interest formula equated to 1750, **(AI)** for correct substitutions into formula.

OR

$N = 2$

$PV = 1500$

$FV = -1750$

$P/Y = 1$

$C/Y = 1$

(AI)(MI)

Note: Award **(AI)** for $FV = 1750$ seen, **(MI)** for other correct entries.

$= 8.01 \% (8.01234\dots\%, 0.0801)$

(AI)(G2) [3 marks]

Total [19 marks]

5. (a) $20lw$ **OR** $V = 20lw$ (A1) [1 mark]
- (b) $3000 = 20lw$ (M1)

Note: Award (M1) for equating their answer to part (a) to 3000.

$$l = \frac{3000}{20w} \quad (M1)$$

Note: Award (M1) for rearranging equation to make l subject of the formula. The above equation must be seen to award (M1).

OR

$$150 = lw \quad (M1)$$

Note: Award (M1) for division by 20 on both sides. The above equation must be seen to award (M1).

$$l = \frac{150}{w} \quad (AG) \quad [2 \text{ marks}]$$

- (c) $S = 2l + 4w + 2(20)$ (M1)

Note: Award (M1) for setting up a correct expression for S .

$$2\left(\frac{150}{w}\right) + 4w + 2(20) \quad (M1)$$

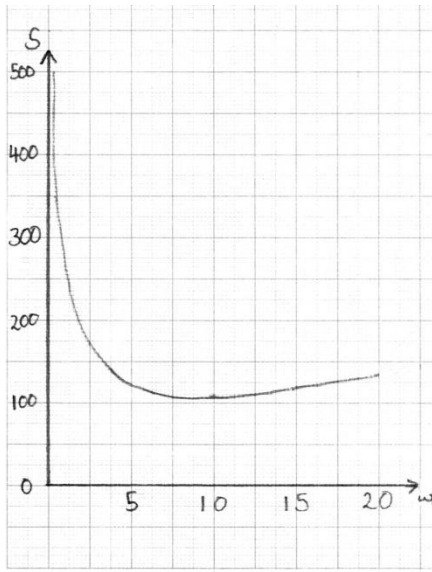
Notes: Award (M1) for correct substitution into the expression for S . The above expression must be seen to award (M1).

$$= 40 + 4w + \frac{300}{w} \quad (AG) \quad [2 \text{ marks}]$$

continued...

Question 5 continued

(d)



(AI)(AI)(AI)(AI) [4 marks]

Note: Award (AI) for correct scales, window and labels on axes, (AI) for approximately correct shape, (AI) for minimum point in approximately correct position, (AI) for asymptotic behaviour at $w = 0$.

Axes must be drawn with a ruler and labeled w and S .

For a smooth curve (with approximately correct shape) there should be **one** continuous thin line, no part of which is straight and no (one-to-many) mappings of w .

The S -axis must be an asymptote. The curve must not touch the S -axis nor must the curve approach the asymptote then deviate away later.

(e) $4 - \frac{300}{w^2}$

(AI)(AI)(AI) [3 marks]

Notes: Award (AI) for 4, (AI) for -300, (AI) for $\frac{1}{w^2}$ or w^{-2} . If extra terms present, award at most (AI)(AI)(A0).

continued...

Question 5 continued

(f) $4 - \frac{300}{w^2} = 0$ OR $\frac{300}{w^2} = 4$ OR $\frac{dS}{dw} = 0$ (M1)

Note: Award (M1) for equating their derivative to zero.

$w = 8.66 (\sqrt{75}, 8.66025\dots)$ (A1)(ft)(G2) [2 marks]

Note: Follow through from their answer to part (e).

(g) $17.3 \left(\frac{150}{\sqrt{75}}, 17.3205\dots \right)$ (A1)(ft) [1 mark]

Note: Follow through from their answer to part (f).

(h) $40 + 4\sqrt{75} + \frac{300}{\sqrt{75}}$ (M1)

Note: Award (M1) for substitution of their answer to part (f) into the expression for S.

$= 110 \text{ (cm)} (40 + 40\sqrt{3}, 109.282\dots)$ (A1)(ft)(G2) [2 marks]

Note: Do not accept 109.
Follow through from their answers to parts (f) and (g).

Total [17 marks]

6. (a) 0 (AI)(GI) [1 mark]
 (b) $1.8 = a(3)^2 + 0$ (MI)

OR

$1.8 = a(-3)^2 + 0$ (MI)

Note: Award (MI) for substitution of $y = 1.8$ or $x = 3$ and their value of c into equation. 0 may be implied.

$a = 0.2 \left(\frac{1}{5} \right)$ (AI)(ft)(GI) [2 marks]

Note: Follow through from their answer to part (a). Award (GI) for a correct answer only.

(c) $y = 0.2x^2$ (AI)(ft) [1 mark]

Note: Follow through from their answers to parts (a) and (b). Answer must be an equation.

(d) $0.2 \times (2.4)^2$ (MI)
 $= 1.15 \text{ (m) } (1.152)$ (AI)(ft)(GI) [2 marks]

Notes: Award (MI) for correctly substituted formula, (AI) for correct answer. Follow through from their answer to part (c). Award (GI) for a correct answer only.

- (e) y is the height (AI)
 positive value of x is half the width (or equivalent) (AI) [2 marks]

(f) $0.9 = 0.2x^2$ (MI)

Note: Award (MI) for setting their equation equal to 0.9.

$x = \pm 2.12 \text{ (m) } \left(\pm \frac{3}{2} \sqrt{2}, \pm \sqrt{4.5}, \pm 2.12132 \dots \right)$ (AI)(ft)(GI) [2 marks]

Note: Accept 2.12. Award (GI) for a correct answer only.

Question 6 continued

(g) (i) 2.55×5 *(M1)*

Note: Award *(M1)* for correct substitution in formula.

$= 12.8 \text{ (m}^3\text{)} \text{ (12.75 (m}^3\text{))}$ *(A1)(G2) [2 marks]*

(ii) $\frac{12.75}{36} \times 100$ *(M1)*

Note: Award *(M1)* for correct quotient multiplied by 100.

$= 35.4 \text{ (\%)} \text{ (35.4166...)}$ *(A1)(ft)(G2) [2 marks]*

Note: Award *(G2)* for 35.6 (%) (35.5555... (%)).
Follow through from their answer to part (g)(i).

Total [14 marks]
