



International Baccalaureate®
Baccalauréat International
Bachillerato Internacional

Mathematical Studies

Standard level

Specimen papers 1 and 2

For first examinations in 2014

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MATHEMATICAL STUDIES
STANDARD LEVEL
PAPER 1

SPECIMEN PAPER

1 hour 30 minutes

Candidate session number

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Examination code

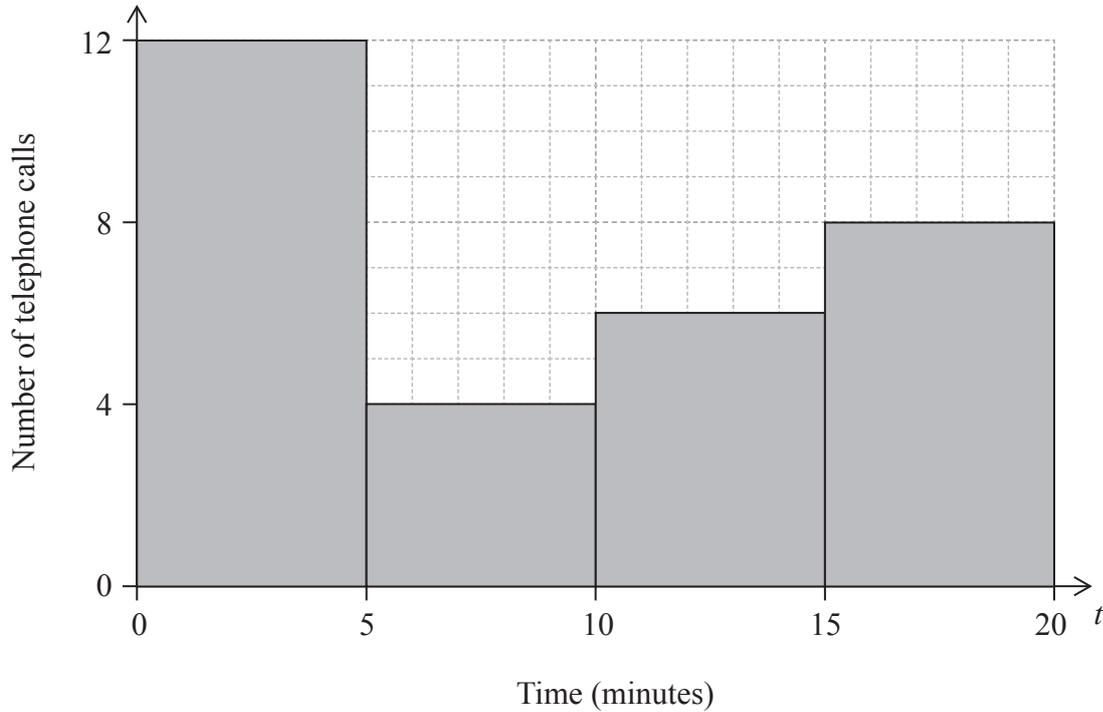
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INSTRUCTIONS TO CANDIDATES

- Write your session number in the boxes above.
- Do not open this examination paper until instructed to do so.
- A graphic display calculator is required for this paper.
- A clean copy of the **Mathematical Studies SL formula booklet** is required for this paper.
- Answer all questions.
- Write your answers in the boxes provided.
- Unless otherwise stated in the question, all numerical answers should be given exactly or correct to three significant figures.
- The maximum mark for this examination paper is [90 marks].

Maximum marks will be given for correct answers. Where an answer is incorrect, some marks may be given for a correct method, provided this is shown by written working. Write your answers in the answer boxes provided. Solutions found from a graphic display calculator should be supported by suitable working, e.g. if graphs are used to find a solution, you should sketch these as part of your answer.

1. Consider the frequency histogram for the distribution of the time, t , in minutes of telephone calls that Helen made last week.



- (a) Complete the frequency table for this distribution.

[2 marks]

Time (minutes)	Number of telephone calls
$0 < t \leq 5$	
$5 < t \leq 10$	
$10 < t \leq 15$	
$15 < t \leq 20$	

(This question continues on the following page)

(Question 1 continued)

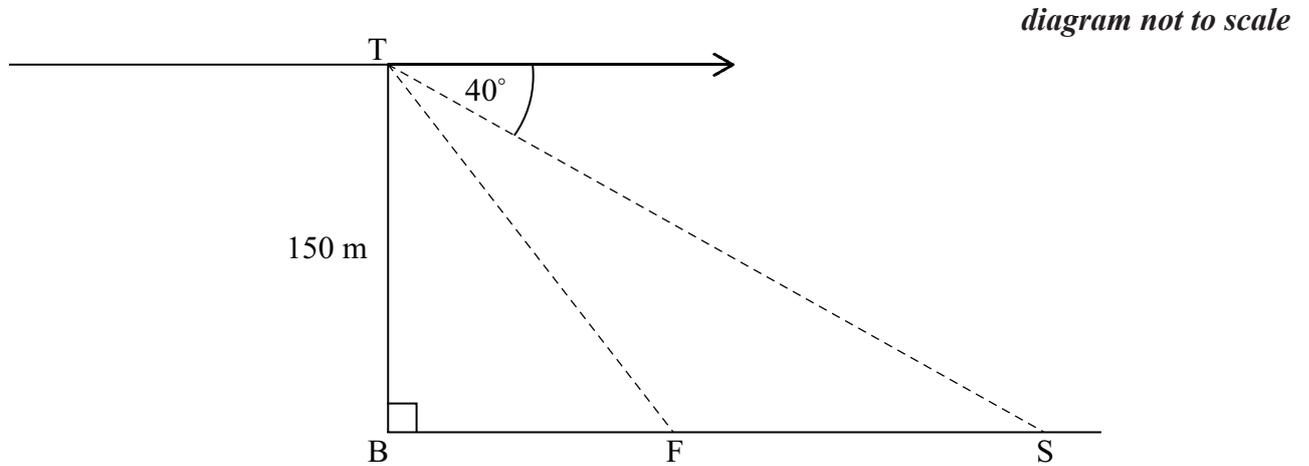
- (b) Write down the modal class. *[1 mark]*
- (c) Write down the mid interval value of the $10 < t \leq 15$ class. *[1 mark]*
- (d) Use your graphic display calculator to find an estimate for the mean time. *[2 marks]*

Working:

Answers:

- (b)
- (c)
- (d)

2. Tom stands at the top, T, of a vertical cliff 150 m high and sees a fishing boat, F, and a ship, S. B represents a point at the bottom of the cliff directly below T. The angle of depression of the ship is 40° and the angle of depression of the fishing boat is 55° .



- (a) Calculate, SB, the distance between the ship and the bottom of the cliff. *[2 marks]*
- (b) Calculate, SF, the distance between the ship and the fishing boat. Give your answer correct to the nearest metre. *[4 marks]*

Working:

Answers:

- (a)
- (b)

3. Consider each of the following statements

p: Alex is from Uruguay

q: Alex is a scientist

r: Alex plays the flute

(a) Write the following argument in words

$$\neg r \Rightarrow (q \vee p)$$

[3 marks]

(b) Complete the truth table for the argument in part (a) using the values below for *p*, *q*, *r* and $\neg r$.

[2 marks]

<i>p</i>	<i>q</i>	<i>r</i>	$\neg r$	$q \vee p$	$\neg r \Rightarrow (q \vee p)$
T	T	T	F		
T	T	F	T		
T	F	T	F		
T	F	F	T		
F	T	T	F		
F	T	F	T		
F	F	T	F		
F	F	F	T		

(c) The argument $\neg r \Rightarrow (q \vee p)$ is invalid. State the reason for this.

[1 mark]

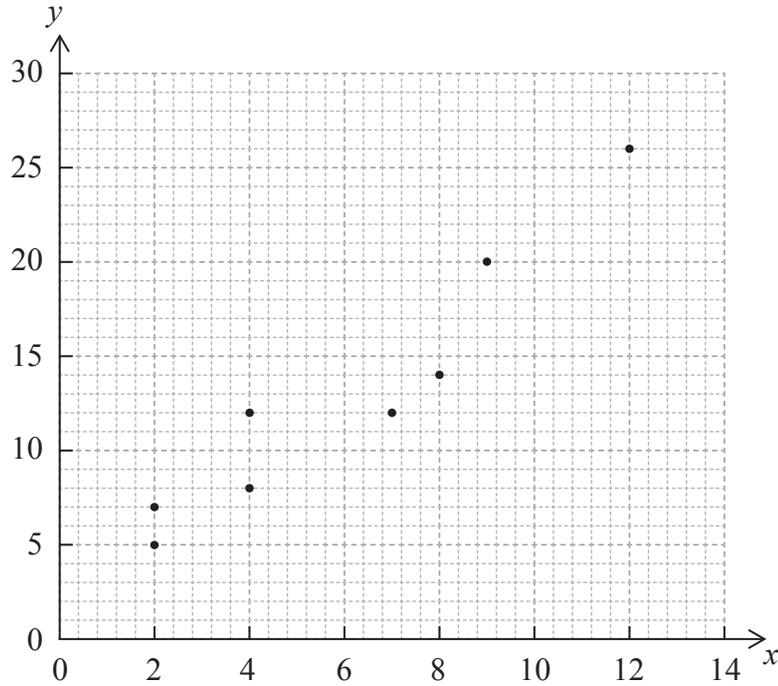
Working:

Answers:

- (a)
-
-
- (c)
-

4. Consider the following set of data which is plotted on the scatter diagram below.

x	2	4	7	12	4	8	9	2
y	5	8	12	26	12	14	20	7



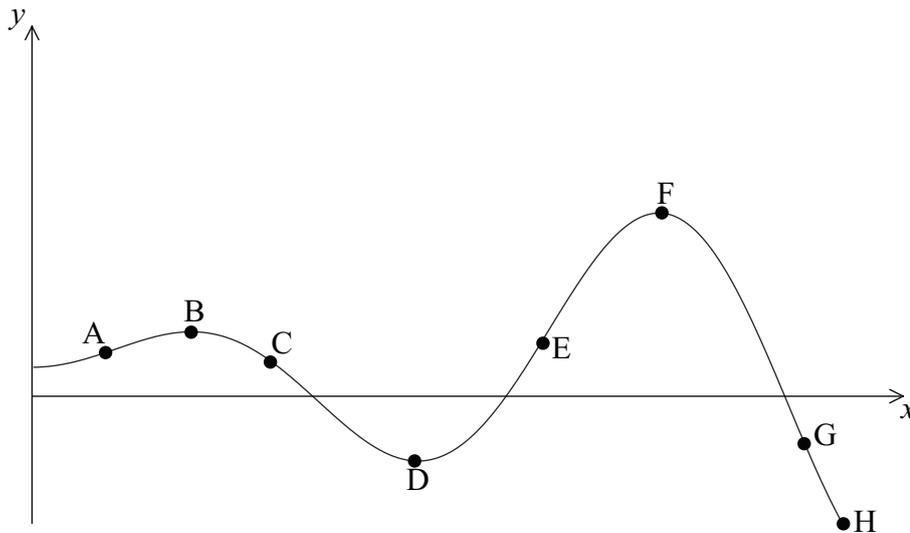
- (a) Write down the coordinates of the mean point (\bar{x}, \bar{y}) . [2 marks]
- (b) Write down the value of r , the Pearson's product-moment correlation coefficient for this set of data. [2 marks]
- (c) Draw the regression line for y on x on the set of axes above. [2 marks]

Working:

Answers:

- (a)
- (b)

5. Consider the graph of the function $y = f(x)$ defined below.



Write down **all** the labelled points on the curve

- (a) that are local maximum points; [1 mark]
- (b) where the function attains its least value; [1 mark]
- (c) where the function attains its greatest value; [1 mark]
- (d) where the gradient of the tangent to the curve is positive; [1 mark]
- (e) where $f(x) > 0$ and $f'(x) < 0$. [2 marks]

Working:

Answers:

- (a)
- (b)
- (c)
- (d)
- (e)

6. The diagram shows a rectangular based right pyramid VABCD in which $AD = 20\text{ cm}$, $DC = 15\text{ cm}$ and the height of the pyramid, $VN = 30\text{ cm}$.

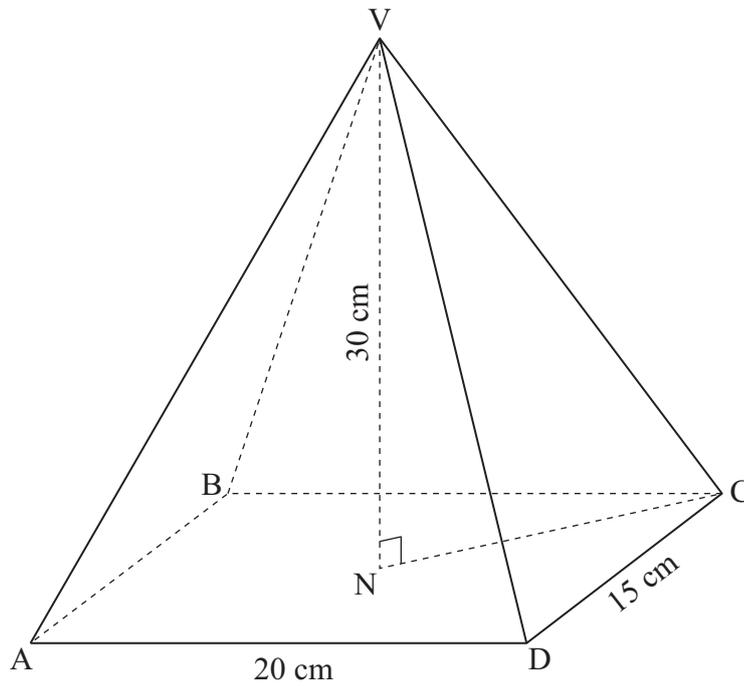


diagram not to scale

Calculate

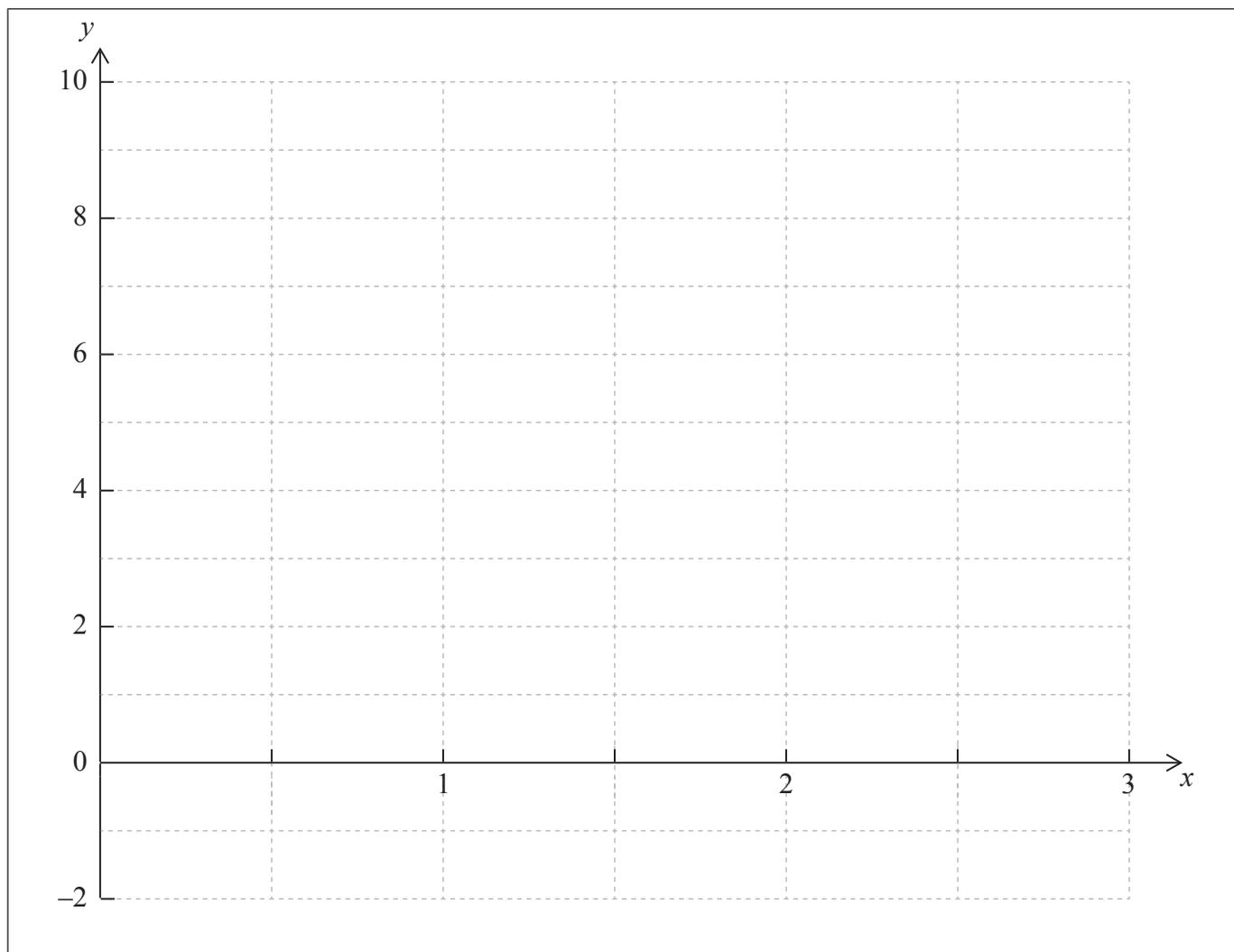
- (a) (i) the length of AC;
(ii) the length of VC. [4 marks]
- (b) the angle between VC and the base ABCD. [2 marks]

Working:

Answers:

- (a) (i)
(ii)
(b)

7. (a) On the grid below sketch the graph of the function $f(x) = 2(1.6)^x$ for the domain $0 \leq x \leq 3$. [2 marks]



- (b) Write down the coordinates of the y -intercept of the graph of $y = f(x)$. [1 mark]
- (c) On the grid draw the graph of the function $g(x) = 5 - 2x$ for the domain $0 \leq x \leq 3$. [2 marks]
- (d) Use your graphic display calculator to solve $f(x) = g(x)$. [1 mark]

<p><i>Working:</i></p>	<p><i>Answers:</i></p> <p>(b)</p> <p>(d)</p>
------------------------	--

8. Members of a certain club are required to register for one of three sports, badminton, volleyball or table tennis. The number of club members of each gender choosing each sport in a particular year is shown in the table below.

A χ^2 (Chi-squared) test at the 5 % significance level is used to determine whether the choice of sport is independent of gender.

	Badminton	Volleyball	Table tennis
Male	40	20	10
Female	20	15	15

- (a) Find the expected number of female volleyball players under this hypothesis. *[2 marks]*

- (b) Write down the p -value for the test. *[2 marks]*

- (c) State, with a reason, the conclusion of the test. *[2 marks]*

Working:

Answers:

- (a)
- (b)
- (c)
.....

9. Consider the curve $y = x^2$.

(a) Write down $\frac{dy}{dx}$. [1 mark]

The point P(3, 9) lies on the curve $y = x^2$.

(b) Find the gradient of the tangent to the curve at P. [2 marks]

(c) Find the equation of the normal to the curve at P. Give your answer in the form $y = mx + c$. [3 marks]

Working:

Answers:

- (a)
- (b)
- (c)

10. Consider the following statements about the quadrilateral ABCD

q : ABCD has four equal sides

s : ABCD is a square

- (a) Express in words the statement, $s \Rightarrow q$. [2 marks]
- (b) Write down in words, the inverse of the statement, $s \Rightarrow q$. [2 marks]
- (c) Determine the validity of the argument in (b). Give a reason for your decision. [2 marks]

Working:

Answers:

- (a)
-
- (b)
-
-
- (c)
-
-

11. Yun Bin invests 5000 euros in an account which pays a nominal annual interest rate of 6.25 % , **compounded monthly**.
Give all answers correct to two decimal places.

Find

- (a) the value of the investment after 3 years; *[3 marks]*
- (b) the difference in the final value of the investment if the interest was compounded quarterly at the same nominal rate. *[3 marks]*

Working:

Answers:

- (a)
- (b)

12. A child's toy consists of a hemisphere with a right circular cone on top. The height of the cone is 12 cm and the radius of its base is 5 cm. The toy is painted red.

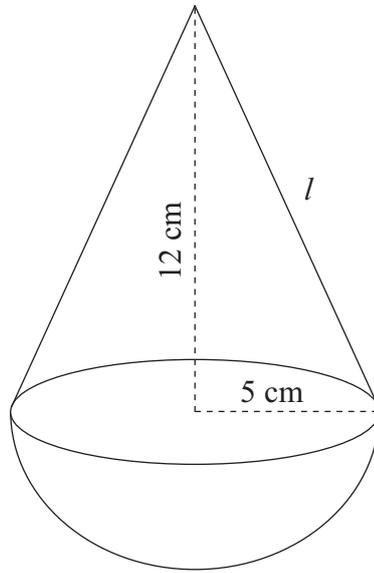


diagram not to scale

- (a) Calculate the length, l , of the slant height of the cone. *[2 marks]*
- (b) Calculate the area that is painted red. *[4 marks]*

Working:

Answers:

- (a)
- (b)

13. A liquid is heated so that after 20 seconds of heating its temperature, T , is 25°C and after 50 seconds of heating its temperature is 37°C .

The temperature of the liquid at time t can be modelled by $T = at + b$, where t is the time in seconds after the start of heating.

Using this model one equation that can be formed is $20a + b = 25$

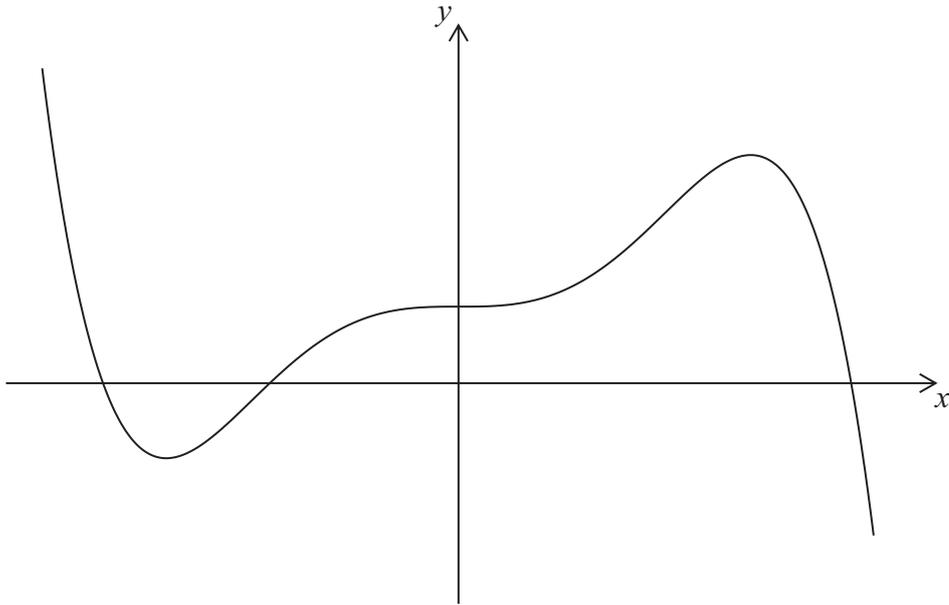
- (a) Using the model, write down a second equation in a and b . *[2 marks]*
- (b) Using your graphic display calculator or otherwise, find the value of a and of b . *[2 marks]*
- (c) Use the model to predict the temperature of the liquid 60 seconds after the start of heating. *[2 marks]*

Working:

Answers:

- (a)
- (b)
- (c)

14. A sketch of the function $f(x) = 5x^3 - 3x^5 + 1$ is shown for $-1.5 \leq x \leq 1.5$ and $-6 \leq y \leq 6$.



- (a) Write down $f'(x)$. [2 marks]
- (b) Find the equation of the tangent to the graph of $y = f(x)$ at $(1, 3)$. [2 marks]
- (c) Write down the coordinates of the second point where this tangent intersects the graph of $y = f(x)$. [2 marks]

Working:

Answers:

- (a)
- (b)
- (c)

15. A small manufacturing company makes and sells x machines each month. The monthly cost C , in dollars, of making x machines is given by

$$C(x) = 2600 + 0.4x^2.$$

The monthly income I , in dollars, obtained by selling x machines is given by

$$I(x) = 150x - 0.6x^2.$$

$P(x)$ is the monthly profit obtained by selling x machines.

- (a) Find $P(x)$. [2 marks]

- (b) Find the number of machines that should be made and sold each month to maximize $P(x)$. [2 marks]

- (c) Use your answer to part (b) to find the selling price of **each machine** in order to maximize $P(x)$. [2 marks]

Working:

Answers:

- (a)
- (b)
- (c)

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will not be marked.

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MARKSCHEME

SPECIMEN PAPER

MATHEMATICAL STUDIES

Standard Level

Paper 1

Paper 1 Markscheme
Instructions to Examiners

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

The number of marks for each question is 6.

1 Abbreviations

The markscheme may make use of the following abbreviations:

M Marks awarded for **Method**

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

C Marks awarded for **Correct** answers (irrespective of working shown)

R Marks awarded for clear **Reasoning**

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 the candidate has full marks on a question use the **C6** annotation, if the candidate has made an attempt but scores zero marks use **C0**. If there is no attempt use the No response button. If a candidate does not score full or zero marks then full annotations **MUST** be shown.
- (c) In this paper, if the **correct answer is seen on the answer line the** maximum mark is awarded. **There is no need to check the working!** Award **C** marks and move on.
- (d) If the answer does not appear on the answer line, but the correct answer is seen in the working box with no subsequent working, award the maximum mark.
- (e) If the **answer is wrong**, marks should be awarded for the working according to the markscheme.
- (f) Working crossed out by the candidate should not be awarded any marks. Where candidates have written two solutions to a question, only the first solution should be marked.
- (g) A correct answer in the working box transcribed inaccurately to the answer line can receive full marks.
- (h) If correct working results in a correct answer **in the working box** but then further working is developed, full marks should **not** be awarded. In most such cases it will be a single final answer mark that is lost, however, a statement on the answer line should always be taken as the candidate's final decision on the answer **as long as it is unambiguous**.
Accuracy of numerical answers is an exception to this rule- see Section 5.

Example: Factorise $x^2 - 5x - 6$

Markscheme	Candidates' Scripts	Marking
$(x-6)(x+1)$ (AI)(AI)	(i) Answer line: $(x+6)(x+1)$	(A0)(AI)
	(ii) Working box: $(x-6)(x+1)$ followed by $x=6$ and -1 , or just $6, -1$ in either working box or on answer line.	(AI)
		(A0)

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. Markschemes 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 (e.g. 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
(a) $\frac{\sin A}{3} = \frac{\sin 30}{4}$ (MI)(AI)	(a) $\frac{\sin A}{4} = \frac{\sin 30}{3}$	(MI)(A0)
$A = 22.0^\circ$ (22.0243...) (AI)	$A = 41.8^\circ$ <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>	(A0)
(b) $x = 7 \tan(22.0243...^\circ)$ (MI) $= 2.83$ (2.83163...) (AI)(ft)	(b) case (i) $x = 7 \tan 41.8^\circ$ $= 6.26$ but case (ii) 6.26	(MI) (AI)(ft) (C0)
		<i>since no working shown</i>

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 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)** is not awarded for a correct answer if no reason or the wrong reason is given.

- (c) **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.*

- (d) 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.

- (e) 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 (*e.g.* complement): A' ; \bar{A} ; A^c ; $U - A$; $(A; U \setminus A$.

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

- (f) **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 an exception should be raised through scoris to the team leader.

As from Nov 11 the AP, FP and UP penalties will no longer apply. Accuracy and units 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

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.

Note: The unrounded answer may appear in either the working box or on the final answer line.

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)**.

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 summarised in the table below and illustrated in the examples which follow.

	If candidates final answer is given ...				
	Exact or correct to 3 or more sf	Incorrect to 3sf	Correct to 2sf ³	Incorrect to 2sf	Correct or incorrect to 1sf
Unrounded answer seen ¹	Award the final (AI) irrespective of correct or incorrect rounding				
Unrounded answer not seen ²	(AI)	(A0)	(AI)	(A0)	(A0)
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 in the working box followed by 9; 9.4; 9.43; 9.434 etc (correctly rounded) (ii) 9.43398... is seen in the working box followed by 9.433; 9.44 etc (incorrectly rounded) (iii) 9.4 (iv) 9 (v) 9.3 (vi) 9.44	(AI) (AI) (AI) (A0) (correct to 1sf) (A0) (incorrectly rounded to 2sf) (A0) (incorrectly rounded to 3sf)

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

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

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 less than three significant figures if the result is still exact. Reduction of a fraction to its lowest terms is **not** essential.

Ratios of π and answers taking the form of square roots of integers or any rational power of an integer (e.g. $\sqrt{13}, 2^{\frac{2}{3}}, \sqrt[4]{5}$,) may be accepted as exact answers. All other powers (e.g. 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 2dp.

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

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 mark 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.

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

8 Graphic Display Calculators

Candidates will often obtain 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.

BEFORE MARKING ANY SCRIPT YOU SHOULD CHECK WHETHER OR NOT THERE ARE ANY SUPPLEMENTARY SHEETS ADDED TO THE SCRIPT

QUESTION 1

(a)	Time (minutes)	Number of telephone calls		
	$0 < t \leq 5$	12		
	$5 < t \leq 10$	4		
	$10 < t \leq 15$	6		
	$15 < t \leq 20$	8	(A2)	(C2)

Note: Award (A2) for four correct entries, (A1) for three correct entries, (A0) otherwise.

- (b) $0 < t \leq 5$ (A1) (C1)
- (c) 12.5 (A1) (C1)
- (d) $\frac{275}{30}$ (M1)

Note: Award (M1) for division with 275 seen.

$= 9.17$ (9.16666...) (A1)(ft) (C2)

Note: Follow through from their parts (a) and (c), irrespective of whether working is shown.

[6 marks]

QUESTION 2

(a) $150 \tan 50$ (M1)

OR

$\frac{150}{\tan 40}$ (M1)

$= 179$ (m) (178.763...) (A1) (C2)

(b) $150 \tan 50 - 150 \tan 35$ (M1)(M1)

Note: Award (M1) for $150 \tan 35$, (M1) for subtraction from their part (a).

$= 73.7$ (m) (73.7319...) (A1)(ft)

$= 74$ (m) (A1)(ft) (C4)

Note: The final (A1) is awarded for the correct rounding of their answer to (b).

Note: There will always be one answer with a specified degree of accuracy on each paper.

[6 marks]

QUESTION 3

- (a) If Alex does not play the flute then he is **either** a scientist **or** from Uruguay.

(AI)(AI)(AI) (C3)

Note: Award (AI) if... then, correct (AI) antecedent, (AI) correct consequent.

(b)

p	q	r	$\neg r$	$q \vee p$	$\neg r \Rightarrow (q \vee p)$
T	T	T	F	T	T
T	T	F	T	T	T
T	F	T	F	T	T
T	F	F	T	T	T
F	T	T	F	T	T
F	T	F	T	T	T
F	F	T	F	F	T
F	F	F	T	F	F

(AI)(AI) (C2)

- (c) Not all entries in the final column are T.

(R1) (C1)
[6 marks]

QUESTION 4

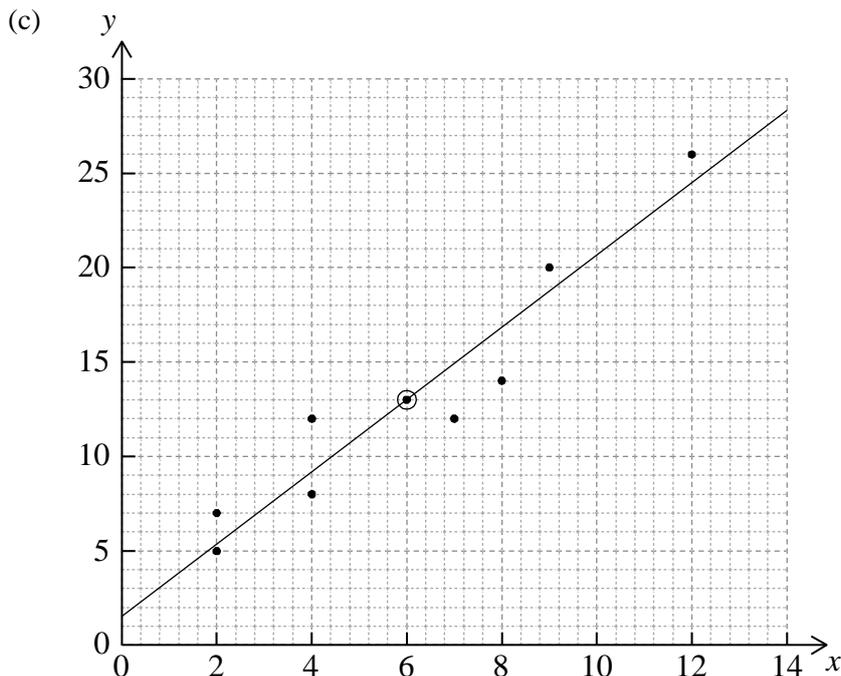
- (a) (6, 13)

(AI)(AI) (C2)

- (b) 0.952 (0.95202...)

(A2) (C2)

Note: Award (A0) for 0.9.



(AI) y intercept at $y = 1.8$ (accept between 1 and 2)

(AI)(ft) line passes through their mean point

(AI)(AI)(ft) (C2)
[6 marks]

QUESTION 5

- (a) B, F (C1)
 - (b) H (C1)
 - (c) F (C1)
 - (d) A, E (C1)
 - (e) C (C2)
- [6 marks]**

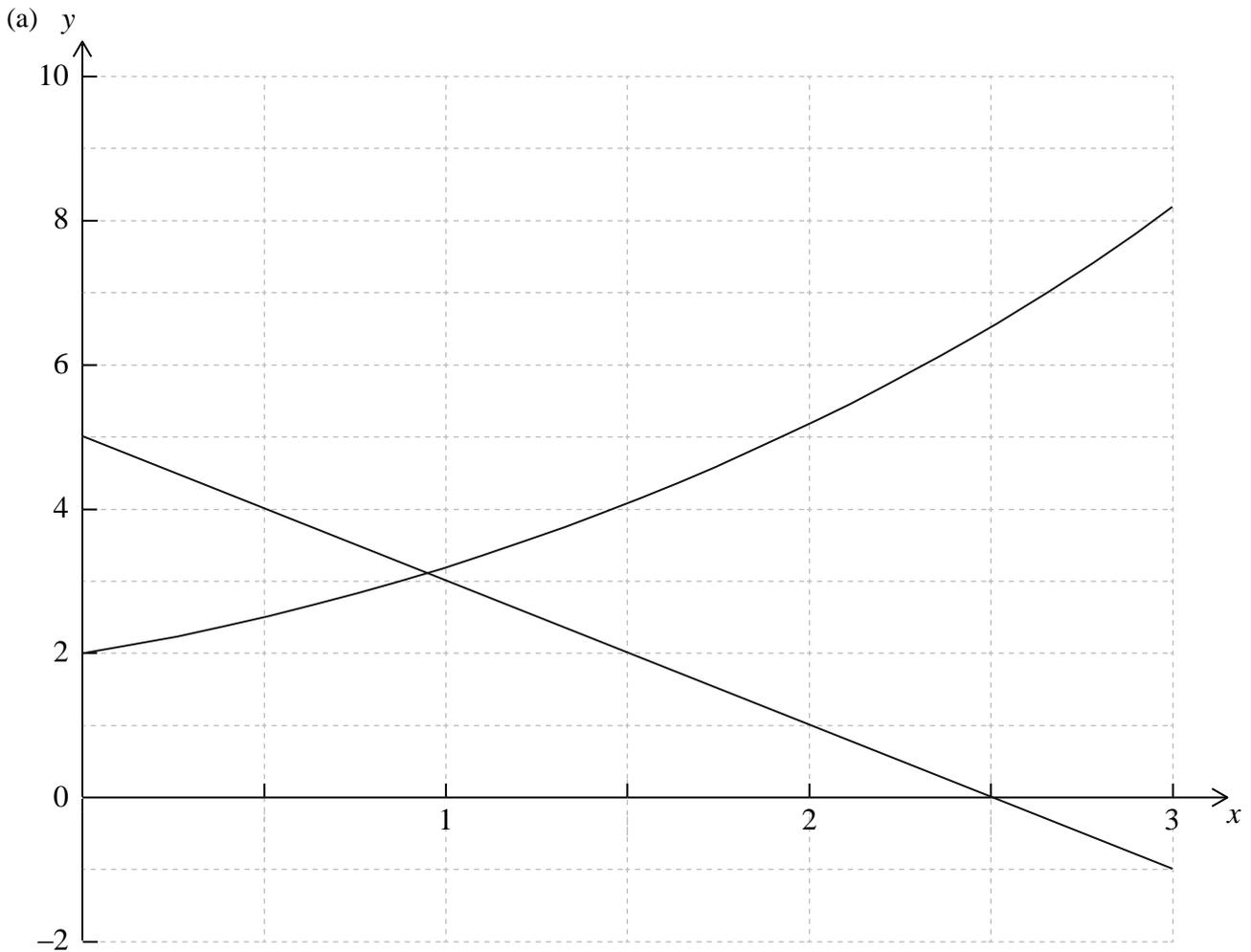
QUESTION 6

- (a) (i) $\sqrt{15^2 + 20^2}$ (M1)
- Note:** Award (M1) for correct substitution in Pythagoras Formula.
- AC = 25 (cm) (A1) (C2)
 - (ii) $\sqrt{12.5^2 + 30^2}$ (M1)
- Note:** Award (M1) for correct substitution in Pythagoras Formula.
- VC = 32.5 (cm) (A1)(ft) (C2)
- Note:** Follow through from their AC found in part (a).
- (b) $\sin VCN = \frac{30}{32.5}$ **OR** $\tan VCN = \frac{30}{12.5}$ **OR** $\cos VCN = \frac{12.5}{32.5}$ (M1)
 - $= 67.4^\circ$ (67.3801...) (A1)(ft) (C2)

Note: Accept alternative methods. Follow through from part (a) and/or part (b).

[6 marks]

QUESTION 7



Note: Award *(AI)* correct endpoints, *(AI)* for smooth curve.

(AI)(AI) *(C2)*

(b) $(0, 2)$

(AI) *(C1)*

Note: Accept $x = 0, y = 2$

(c) Straight line in the given domain
 Axes intercepts in the correct positions

(AI)
(AI) *(C2)*

(d) $x = 0.943$ (0.94259...)

(AI) *(C1)*

Note: Award *(A0)* if y-coordinate given.

[6 marks]

QUESTION 8

- (a) $\frac{50}{120} \times \frac{35}{120} \times 120$ **OR** $\left(\frac{50 \times 35}{120}\right)$ (M1)
- =14.6 (14.5833...) (A1) (C2)
- (b) 0.0746 (A2) (C2)
- (c) Since p -value > 5 %, the choice of the sport is independent of gender. (RI)(A1)(ft) (C2)

Note: The (RI) is awarded for the explicit comparison, the (A1)(ft) is awarded for a consistent conclusion with their answer in part (c).
It is therefore possible that (RI)(A0) may be awarded, but (R0)(A1) can never be awarded.

[6 marks]

QUESTION 9

- (a) $2x$ (AI) (C1)
- (b) 2×3 (MI)
 $= 6$ (AI) (C2)
- (c) $m(\text{perp}) = -\frac{1}{6}$ (AI)(ft)

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

Equation $(y - 9) = -\frac{1}{6}(x - 3)$ (MI)

Note: Award (MI) for correct substitution in any formula for equation of a line.

$y = -\frac{1}{6}x + 9\frac{1}{2}$ (AI)(ft) (C3)

Note: Follow through from correct substitution of their gradient of the normal.

Note: There are no extra marks awarded for rearranging the equation to the form $y = mx + c$.

[6 marks]

QUESTION 10

- (a) If ABCD is a square, then ABCD has four equal sides (AI)(AI) (C2)
- Note:** Award (AI) for if...then, (AI) for propositions in the correct order.
- (b) If ABCD is not a square, then ABCD does not have four equal sides (AI)(AI) (C2)
- Note:** Award (AI) for if...then, (AI) for propositions in the correct order.
- (c) Not a valid argument. ABCD may have 4 equal sides but will not **necessarily** be a square. (It may be a rhombus) (AI)(RI) (C2)

Note: Award (RI) for correct reasoning, award (AI) for a consistent conclusion with their answer in part (b).
 It is therefore possible that (RI)(A0) may be awarded, but (R0)(AI) can never be awarded.

Note: Simple examples of determining the validity of an argument without the use of a truth table may be tested.

[6 marks]

QUESTION 11

11. (a) $FV = 5000 \left(1 + \frac{6.25}{1200} \right)^{3 \times 12}$ (MI)(AI)

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

OR

$N = 3$
 $I \% = 6.25$
 $PV = -5000$
 $P / Y = 1$
 $C / Y = 12$

(MI)(AI)

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

OR

$N = 36$
 $I \% = 6.25$
 $PV = -5000$
 $P / Y = 12$
 $C / Y = 12$

(MI)(AI)

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

$= 6028.22$

(AI) (C3)

Note: The answer should be given correct to two decimal places or the final (AI) is not awarded.

(b) $FV = 5000 \left(1 + \frac{6.25}{400} \right)^{3 \times 4}$ (MI)

Note: Award (MI) for correctly substituted compound interest formula.

OR

$N = 3$
 $I \% = 6.25$
 $PV = -5000$
 $P / Y = 1$
 $C / Y = 4$

(MI)

Note: Award (MI) for all correct entries seen.

continued...

Question 11 continued

OR

$$N = 12$$

$$I \% = 6.25$$

$$PV = -5000$$

$$P / Y = 4$$

$$C / Y = 4$$

(MI)

Note: Award (MI) for all correct entries seen.

$$FV = 6022.41$$

$$\text{Difference} = 5.80$$

(AI)

(AI)(ft)

(C3)

Notes: Accept 5.81. This answer should be given correct to two decimal places or the final (AI) is not awarded unless this has already been penalized in part (a). Follow through from part (a).

Notes: Illustrating use of GDC notation acceptable in this case only. However on P2 an answer given with no working would receive G2.

[6 marks]

QUESTION 12

(a) $\sqrt{5^2 + 12^2}$

(MI)

Note: Award (MI) for correct substitution in Pythagoras Formula.

$$= 13 \text{ (cm)}$$

(AI)

(C2)

(b) $\text{Area} = 2\pi(5)^2 + \pi(5)(13)$

(MI)(MI)(MI)

Notes: Award (MI) for surface area of hemisphere, (MI) for surface of cone, (MI) for addition of two surface areas. Follow through from their answer to part (a).

$$= 361 \text{ cm}^2 \text{ (361.283...)}$$

(AI)(ft)

(C4)

Note: The answer is 361 cm^2 , the units are required.

[6 marks]

QUESTION 13

(a) $50a + b = 37$ (AI)(AI) (C2)

Note: Award (AI) for $50a + b$, (AI) for $= 37$

(b) $a = 0.4, b = 17$ (AI)(ft)(AI)(ft) (C2)

Notes: Award (MI) for attempt to solve their equations if this is done analytically.
If the GDC is used, award (ft) even if no working seen.

(c) $T = 0.4(60) + 17$ (MI)

Note: Award (MI) for correct substitution of their values and 60 into equation for T .

$T = 41$ (°C) (AI)(ft) (C2)

Note: Follow through from their part (b).

[6 marks]

QUESTION 14

(a) $f'(x) = 15x^2 - 15x^4$ (AI)(AI) (C2)

Note: Award a maximum of (AI)(A0) if extra terms seen.

(b) $f'(1) = 0$ (MI)

Note: Award (MI) for $f'(x) = 0$

$y = 3$ (AI)(ft) (C2)

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

(c) $(-1.38, 3)$ $(-1.38481\dots, 3)$ (AI)(ft)(AI)(ft) (C2)

Note: Follow through from their answer to parts (a) and (b).

Note: Accept $x = -1.38, y = 3$ ($x = -1.38481\dots, y = 3$).

[6 marks]

QUESTION 15

(a) $P(x) = I(x) - C(x)$ (MI)
 $= -x^2 + 150x - 2600$ (AI) (C2)

(b) $-2x + 150 = 0$ (MI)

Note: Award (MI) for setting $P'(x) = 0$.

OR

Award (MI) for sketch of $P(x)$ and maximum point identified. (MI)

$x = 75$ (AI)(ft) (C2)

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

(c) $\frac{7875}{75}$ (MI)

Note: Award (MI) for 7875 seen.

$= 105$ (AI)(ft) (C2)

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

[6 marks]



**MATHEMATICAL STUDIES
STANDARD LEVEL
PAPER 2**

SPECIMEN PAPER

1 hour 30 minutes

INSTRUCTIONS TO CANDIDATES

- Do not open this examination paper until instructed to do so.
- A graphic display calculator is required for this paper.
- A clean copy of the **Mathematical Studies SL formula booklet** is required for this paper.
- Answer all the questions.
- Unless otherwise stated in the question, all numerical answers should be given exactly or correct to three significant figures.
- The maximum mark for this examination paper is [90 marks].

Please start each question on a new page. You are advised to show all working, where possible. Where an answer is incorrect, some marks may be given for a correct method, provided this is shown by written working. Solutions found from a graphic display calculator should be supported by suitable working, e.g. if graphs are used to find a solution, you should sketch these as part of your answer.

1. [Maximum mark: 13]

The lengths (l) in centimetres of 100 copper pipes at a local building supplier were measured. The results are listed in the table below.

Length l (cm)	Frequency
17.5	12
32.5	26
47.5	32
62.5	21
77.5	9

- (a) Write down the mode. [1 mark]

- (b) Using your graphic display calculator, write down the value of
 - (i) the mean;
 - (ii) the standard deviation;
 - (iii) the median. [4 marks]

- (c) Find the interquartile range. [2 marks]

- (d) Draw a box and whisker diagram for this data, on graph paper, using a scale of 1 cm to represent 5 cm. [4 marks]

Sam estimated the value of the mean of the measured lengths to be 43 cm.

- (e) Find the percentage error of Sam’s estimated mean. [2 marks]

2. [Maximum mark: 12]

An office block, ABCPQR, is built in the shape of a triangular prism with its “footprint”, ABC, on horizontal ground. $AB = 70$ m, $BC = 50$ m and $AC = 30$ m. The vertical height of the office block is 120 m.

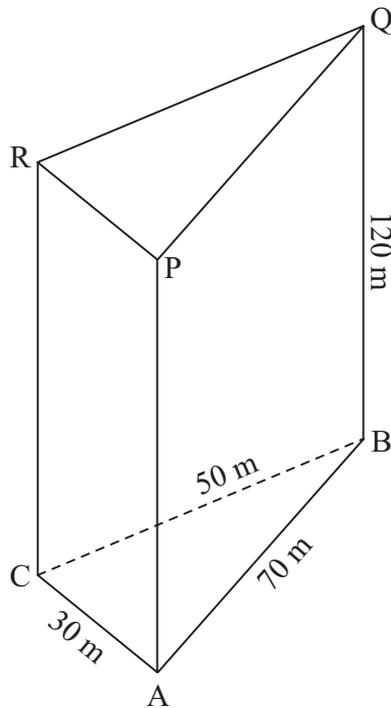


diagram not to scale

- (a) Calculate the size of angle ACB. [3 marks]
- (b) Calculate the area of the building’s footprint, ABC. [3 marks]
- (c) Calculate the volume of the office block. [2 marks]

To stabilize the structure, a steel beam must be made that runs from point C to point Q.

- (d) Calculate the length of CQ. [2 marks]
- (e) Calculate the angle CQ makes with BC. [2 marks]

3. [Maximum mark: 14]

The Brahma chicken produces eggs with weights in grams that are normally distributed about a mean of 55 g with a standard deviation of 7 g. The eggs are classified as small, medium, large or extra large according to their weight, as shown in the table below.

Size	Weight (g)
Small	Weight < 53
Medium	$53 \leq \text{Weight} < 63$
Large	$63 \leq \text{Weight} < 73$
Extra Large	Weight ≥ 73

- (a) Sketch a diagram of the distribution of the weight of Brahma chicken eggs. On your diagram, show clearly the boundaries for the classification of the eggs. [3 marks]

An egg is chosen at random.

- (b) Find the probability that the egg is
- (i) medium;
 - (ii) extra large. [4 marks]

There is a probability of 0.3 that a randomly chosen egg weighs more than w grams.

- (c) Find w . [2 marks]

The probability that a Brahma chicken produces a large size egg is 0.121. Frank's Brahma chickens produce 2000 eggs each month.

- (d) Calculate an estimate of the number of large size eggs produced by Frank's chickens each month. [2 marks]

(This question continues on the following page)

(Question 3 continued)

The selling price, in US dollars (USD), of each size is shown in the table below.

Size	Selling price (USD)
Small	0.30
Medium	0.50
Large	0.65
Extra Large	0.80

The probability that a Brahma chicken produces a small size egg is 0.388.

- (e) Estimate the monthly income, in USD, earned by selling the 2000 eggs.
Give your answer correct to two decimal places.

[3 marks]

4. [Maximum mark: 12]

A deep sea diver notices that the intensity of light, I , below the surface of the ocean decreases with depth, d , according to the formula

$$I = k(1.05)^{-d},$$

where I is expressed as a percentage, d is the depth in metres below the surface and k is a constant.

The intensity of light at the surface is 100 %.

(a) Calculate the value of k . [2 marks]

(b) Find the intensity of light at a depth 25 m below the surface. [2 marks]

To be able to see clearly, a diver needs the intensity of light to be at least 65 %.

(c) Using your graphic display calculator, find the greatest depth below the surface at which she can see clearly. [2 marks]

The table below gives the intensity of light (correct to the nearest integer) at different depths.

Depth (d)	0	10	20	50	80
Intensity (I)	100	61	38	9	2

(d) Using this information draw the graph of I against d for $0 \leq d \leq 100$. Use a scale of 1 cm to represent 10 metres on the horizontal axis and 1 cm to represent 10 % on the vertical axis. [4 marks]

Some sea creatures have adapted so they can see in low intensity light and cannot tolerate too much light.

(e) Indicate clearly on your graph the range of depths sea creatures could inhabit if they can tolerate between 5 % and 35 % of the light intensity at the surface. [2 marks]

5. [Maximum mark: 17]

50 students at Rambling High School were asked how they travelled to school yesterday. All of the students travelled by bus, by car or walked.

- 12 students travelled by car only
- 7 students travelled by bus only
- 5 students travelled by car and walked, but did not use a bus
- 10 students travelled by bus and walked, but did not use a car
- 3 students used all three forms of travel.

(a) Represent this information on a Venn Diagram. [4 marks]

There were 28 students who used a bus to travel to school.

(b) Calculate the number of students

- (i) who travelled by car and by bus but did not walk;
- (ii) who travelled by car. [4 marks]

Tomoko used a bus to travel to school yesterday.

(c) Find the probability that she also walked. [2 marks]

Two students are chosen at random from all 50 students.

(d) Find the probability that

- (i) both students walked;
- (ii) only one of the students walked. [7 marks]

6. [Maximum mark: 22]

Nadia designs a wastepaper bin made in the shape of an **open** cylinder with a volume of 8000 cm^3 .

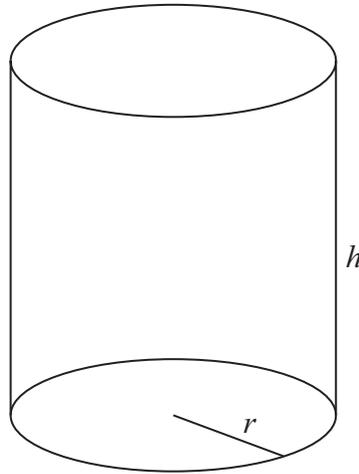


diagram not to scale

Nadia decides to make the radius, r , of the bin 5 cm.

(a) Calculate

- (i) the area of the base of the wastepaper bin;
- (ii) the height, h , of Nadia's wastepaper bin;
- (iii) the total **external** surface area of the wastepaper bin.

[7 marks]

(b) State whether Nadia's design is practical. Give a reason.

[2 marks]

(This question continues on the following page)

(Question 6 continued)

Merryn also designs a cylindrical wastepaper bin with a volume of 8000 cm^3 . She decides to fix the radius of its base so that the **total external surface area** of the bin is minimized.

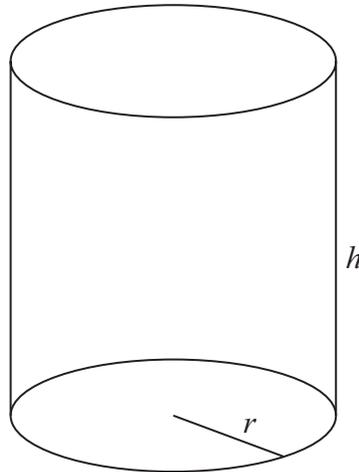


diagram not to scale

Let the radius of the base of Merryn’s wastepaper bin be r , and let its height be h .

- (c) Write down an equation in h and r , using the given volume of the bin. [1 mark]
 - (d) Show that the total external surface area, A , of the bin is $A = \delta r^2 + \frac{16000}{r}$. [2 marks]
 - (e) Write down $\frac{dA}{dr}$. [3 marks]
 - (f) (i) Find the value of r which minimizes the total external surface area of the wastepaper bin.
 - (ii) Calculate the value of h corresponding to this value of r . [5 marks]
 - (g) Determine whether Merryn’s design is an improvement upon Nadia’s. Give a reason. [2 marks]
-



MARKSCHEME

SPECIMEN PAPER

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**, irrespective of 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
$\frac{9-3}{0-5}$ <p style="text-align: right;">(M1)</p> <p><i>Award (M1) for correct substitution in gradient formula</i></p> $= -\frac{6}{5}$ <p style="text-align: right;">(A1)</p>	<p>(i) $\frac{9-3}{0-5} = -\frac{6}{5}$</p> <p>Gradient is $= -\frac{6}{5}$</p> <p style="text-align: right;"><i>(There is clear understanding of the gradient.)</i></p> $y = -\frac{6}{5}x + 9$	<p style="text-align: right;">(M1)</p> <p style="text-align: right;">(A1)</p>
	<p>(ii) $\frac{9-3}{0-5} = -\frac{6}{5}$</p> $y = -\frac{6}{5}x + 9$ <p style="text-align: right;"><i>(There is confusion about what is required.)</i></p>	<p style="text-align: right;">(M1)</p> <p style="text-align: right;">(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 (*e.g.* 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>Award (MI) for substitution in sine rule formula, (AI) for correct substitutions.</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>(Note: the 2nd (AI) here was not marked (ft) and cannot be awarded because there was an earlier error in the same question part.)</p>	<p>(MI)(A0)</p> <p>(use of sine rule but with wrong values)</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>since no working shown</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
(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)	(i) $\frac{\sin A}{3} = \frac{\sin 30}{4}$ $A = 22.0^\circ$ (ii) $A = 22.0^\circ$ <i>Note: G marks are used only if no working has been shown and the answer is correct.</i>	(M1)(A1) (A1) (G2)

- (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 (*e.g.* 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 from Nov 11 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

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)*.
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 summarised 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 3sf	Correct to 2sf ³	Incorrect to 2sf	Correct or incorrect to 1sf
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 etc (correctly rounded)	(AI)
	(ii) 9.43398... is seen followed by 9.433; 9.44 etc (incorrectly rounded)	(AI)
	(iii) 9.4	(AI)
	(iv) 9	(A0) (correct to 1sf)
	(v) 9.3	(A0) (incorrectly rounded to 2sf)
	(vi) 9.44	(A0) (incorrectly rounded to 3sf)

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

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) $BC = \sqrt{32^2 - 30^2}$ (M1) Award (M1) for correct substitution in Pythagorus' formula $= 11.1 (\sqrt{124}, 11.1355\dots)$ (cm) (A1)	(a) $BC = \sqrt{32^2 - 30^2}$ 11 (cm) (2 sf answer only seen, but correct)	(M1) (A1)
(b) $\text{Area} = \frac{1}{2} \times 30 \times 11.1355\dots$ (M1) Award (M1) for correct substitution in area of triangle formula $= 167(167.032\dots)$ (cm ²) (A1)(ft)	(b) case (i) $\text{Area} = \frac{1}{2} \times 30 \times 11$ $= 165$ (cm ²) case (ii) $= 165$ (cm ²) (No working shown, the answer 11 is treated as a ft, so no marks awarded here)	(M1) (working shown) (A1)(ft) (M0)(A0)(ft)

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 less than three significant figures if the result is still exact. Reduction of a fraction to its lowest terms is **not** essential.

Ratios of π and answers taking the form of square roots of integers or any rational power of an integer (e.g. $\sqrt{13}, 2^{\frac{2}{3}}, \sqrt[4]{5}$,) may be accepted as exact answers. All other powers (e.g. 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 2dp.

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

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 mark 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) <i>(Incorrect answer so units not considered)</i>
(b) 3200 m ³ (AI)	(b) 3200 m ²	(A0) <i>(Incorrect units)</i>

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.

QUESTION 1

(a) 47.5 (cm) (AI) [1 mark]

(b) (i) 45.85 (cm) (G2)

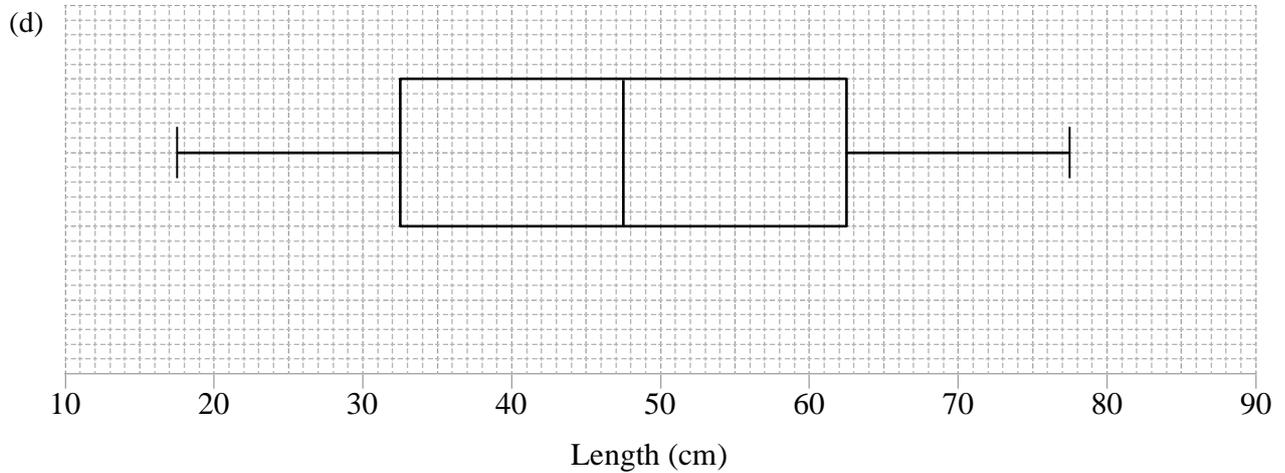
Note: Accept 45.9

(ii) 17.1 (17.0888...) (G1)

(iii) 47.5 (cm) (G1) [4 marks]

(c) $62.5 - 32.5 = 30$ (M1)(AI)(G2) [2 marks]

Note: Award (M1) for correct quartiles seen.



(AI) for correct label and scale
 (AI)(ft) for correct median
 (AI)(ft) for correct quartiles and box
 (AI) for endpoints at 17.5 and 77.5 joined to box by straight lines (AI)(AI)(ft)(AI)(ft)(AI) [4 marks]

Notes: The final (AI) is lost if the lines go through the box.
 Follow through from their parts (b) and (c).

(e) $\varepsilon = \left| \frac{43 - 45.85}{45.85} \right| \times 100\%$ (M1)

Note: Award (M1) for their correct substitution in % error formula.

= 6.22 % (6.21592...) (AI)(ft)(G2) [2 marks]

Notes: Follow through from their answer to part (b)(i).
 Accept 6.32 % with use of 45.9

Total [13 marks]

QUESTION 2

(a) $\cos ACB = \frac{30^2 + 50^2 - 70^2}{2 \times 30 \times 50}$ *(MI)(AI)*

Note: Award *(MI)* for substituted cosine rule formula, *(AI)* for correct substitution.

$ACB = 120^\circ$ *(AI)(G2)* [3 marks]

(b) Area of triangle ABC = $\frac{30(50)\sin 120^\circ}{2}$ *(MI)(AI)(ft)*

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

= 650 m^2 (649.519... m^2) *(AI)(ft)(G2)* [3 marks]

Notes: The answer is 650 m^2 ; the units are required. Follow through from their answer in part (a).

(c) Volume = $649.519... \times 120$ *(MI)*
 = 77900 m^3 (77942.2... m^3) *(AI)(G2)* [2 marks]

Note: The answer is 77900 m^3 ; the units are required.
 Do not penalise lack of units if already penalized in part (b).
 Accept 78000 m^3 from use of 3sf answer 650 m^2 from part (b).

(d) $CQ^2 = 50^2 + 120^2$ *(MI)*
 $CQ = 130 \text{ (m)}$ *(AI)(G2)* [2 marks]

Note: The units are **not** required.

(e) $\tan QCB = \frac{120}{50}$ *(MI)*

Note: Award *(MI)* for correct substituted trig formula.

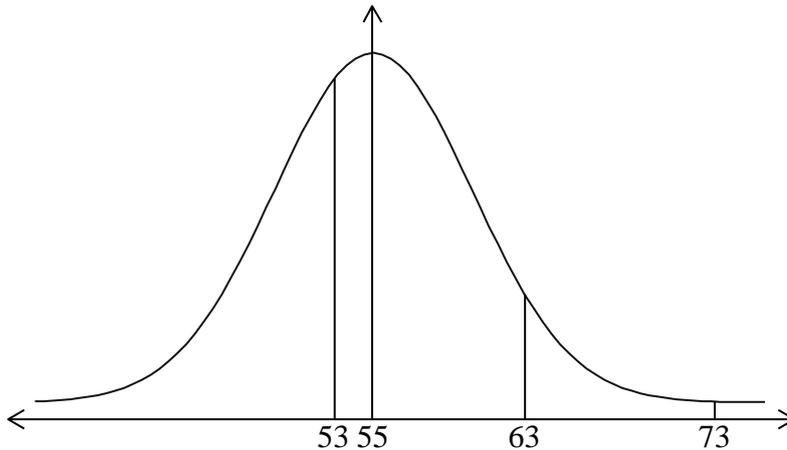
$QCB = 67.4^\circ$ (67.3801... $^\circ$) *(AI)(G2)* [2 marks]

Note: Accept equivalent methods.

Total [12 marks]

QUESTION 3

(a)



(AI) for normal curve with mean of 55 indicated
 (AI) for three lines in approximately the correct position
 (AI) for labels on the three lines

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

(b) (i) $P(53 \leq \text{Weight} < 63) = 0.486$ (0.485902...)

(MI)(AI)(G2)

Note: Award (MI) for correct region indicated on labelled diagram.

(ii) $P(\text{Weight} > 73) = 0.00506$ (0.00506402...)

(MI)(AI)(G2) [4 marks]

Note: Award (MI) for correct region indicated on labelled diagram.

(c) $P(\text{Weight} > w) = 0.3$
 $w = 58.7$ (58.6708...)

(MI)
 (AI)(G2) [2 marks]

Note: Award (MI) for correct region indicated on labelled diagram.

(d) Expected number of large size eggs
 $= 2000(0.121)$
 $= 242$

(MI)
 (AI)(G2) [2 marks]

(e) Expected income
 $= 2000 \times 0.30 \times 0.388 + 2000 \times 0.50 \times 0.486 + 2000 \times 0.65 \times 0.121 +$
 $2000 \times 0.80 \times 0.00506$

(MI)(MI)

Note: Award (MI) for their correct products, (MI) for addition of 4 terms.

$= 884.20$ USD

(AI)(ft)(G3) [3 marks]

Note: Follow through from part (b).

Total [14 marks]

QUESTION 4

(a) $d = 0, k = 100$

(MI)(AI)(G2) [2 marks]

Note: Award (MI) for $d = 0$ seen.

(b) $I = 100 \times (1.05)^{-25} = 29.5$ (%) (29.5302...)

(MI)(AI)(ft)(G2) [2 marks]

(c) $65 = 100 \times (1.05)^{-d}$

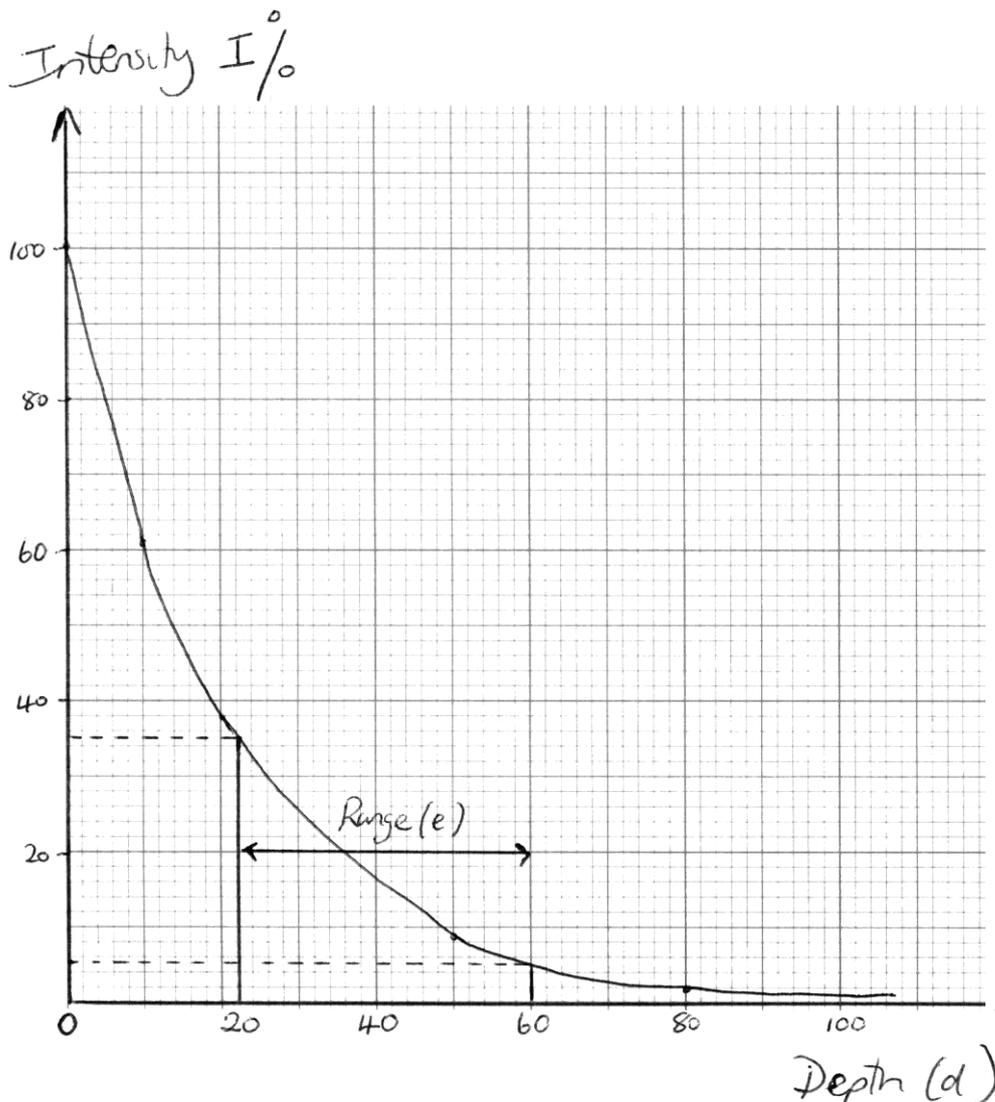
(MI)

Note: Award (MI) for sketch with line drawn at $y = 65$.

$d = 8.83$ (m) (8.82929...)

(AI)(ft)(G2) [2 marks]

(d)



(AI) for labels and scales

(A2) for all points correct, (AI) for 3 or 4 points correct

(AI) for smooth curve asymptotic to the x axis

(A4) [4 marks]

(e) Lines in approx correct positions on graph

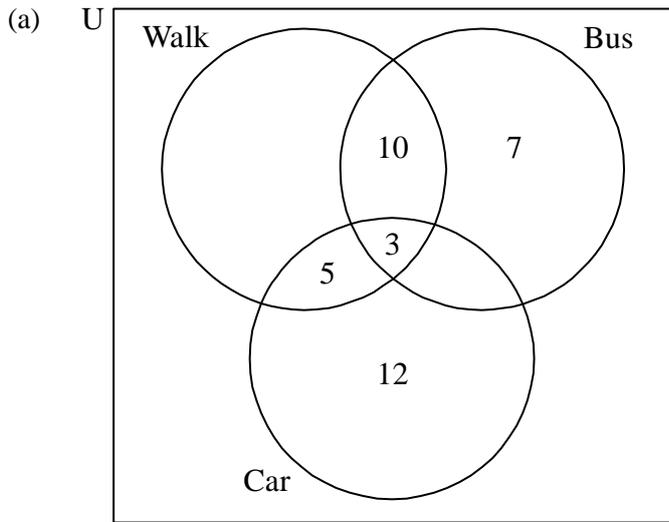
(MI)

The range of values indicated (arrows or shading) 22–60 m

(AI) [2 marks]

Total [12 marks]

QUESTION 5



(A4) [4 marks]

Note: Award (AI) for rectangle and three labelled intersecting circles, (AI) for 3, (AI) for 5 and 10, (AI) for 7 and 12.

(b) (i) $28 - (10 + 3 + 7) = 8$ (M1)(AI)(ft)(G2)

Note: Follow through from their Venn diagram.

(ii) $5 + 3 + 8 + 12 = 28$ (M1)(AI)(ft)(G2) [4 marks]

Note: Follow through from part (b)(i) and their Venn diagram.

(c) $P(\text{walk}|\text{bus}) = \frac{13}{28}$ (0.464, 46.4 %) (0.464285...) (AI)(AI)(ft)(G2) [2 marks]

Note: Award (AI)(ft) for the numerator, (AI) for denominator.

(d) (i) $\frac{23}{50} \times \frac{22}{49}$ (AI)(M1)(M1)

Note: Award (AI) for 23 seen, (M1) for non replacement, (M1) for multiplying their fractions.

$= \frac{506}{2450}$ (0.207, 20.7 %) (0.206530...) (AI)(G3)

(ii) $\frac{23}{50} \times \frac{27}{49} + \frac{27}{50} \times \frac{23}{49}$ (AI)(ft)(M1)

Notes: Award (AI)(ft) for two products, (M1) for adding two products.
Do not penalise in (ii) for consistent use of with replacement.

$= \frac{1242}{2450}$ (0.507, 50.7 %) (0.509638...) (AI)(ft)(G2) [7 marks]

Total [17 marks]

QUESTION 6

(a) (i) $\text{Area} = \pi(5)^2$ (MI)
 $= 78.5 \text{ (cm}^2\text{)} (78.5398\dots)$ (AI)(G2)

Note: Accept 25π

(ii) $8000 = 78.5398\dots \times h$ (MI)
 $h = 102 \text{ (cm)} (101.859\dots)$ (AI)(ft)(G2)

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

(iii) $\text{Area} = \pi(5)^2 + 2\pi(5)(101.859\dots)$ (MI)(MI)

Note: Award (MI) for their substitution in curved surface area formula, (MI) for addition of their two areas.

$= 3280 \text{ (cm}^2\text{)} (3278.53\dots)$ (AI)(ft)(G2) [7 marks]

Note: Follow through from their answers to parts (a)(i) and (ii).

(b) No, it is too tall / narrow. (AI)(ft)(RI) [2 marks]

Note: Follow through from their value for h .

(c) $8000 = \pi r^2 h$ (AI) [1 mark]

(d) $A = \pi r^2 + 2\pi r \left(\frac{8000}{\pi r^2} \right)$ (AI)(MI)

Note: Award (AI) for correct rearrangement of **their** part (c), (MI) for substitution of **their** rearrangement into area formula.

$= \pi r^2 + \frac{16000}{r}$ (AG) [2 marks]

(e) $\frac{dA}{dr} = 2\pi r - 16000r^{-2}$ (AI)(AI)(AI) [3 marks]

Note: Award (AI) for $2\pi r$, (AI) for -16000 (AI) for r^{-2} .
 If an extra term is present award at most (AI)(AI)(A0).

continued...

Question 6 continued

(f) (i) $\frac{dA}{dr} = 0$ (M1)
 $2\pi r^3 - 16000 = 0$ (M1)
 $r = 13.7 \text{ cm (13.6556...)}$ (A1)(ft)

Note: Follow through from their part (e).

(ii) $h = \frac{8000}{\pi(13.65...)^2}$ (M1)
 $= 13.7 \text{ cm (13.6556...)}$ (A1)(ft) [5 marks]

Note: Accept 13.6 if 13.7 used.

(g) Yes or No, accompanied by a consistent and sensible reason. (A1)(R1) [2 marks]

Note: Award (A0)(R0) if no reason is given.

Total [22 marks]
