M08/5/MATSD/SP1/ENG/TZ1/XX/M+

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MARKSCHEME

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MATHEMATICAL STUDIES

Standard Level

Paper 1

20 pages

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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.

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

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 using a **red** pen.

(b) Marks must be noted on candidates' scripts as in the markscheme:

- A correct answer only needs ***C*** marks to be shown, otherwise show the breakdown of individual marks using the abbreviations ***(M1)***, ***(A2)*** *etc*.
- Write down and circle the total for **each question** at the end of the question.
- Transfer the total for **each question** to the front cover sheet and write down the total mark for the paper.

(c) In this paper, the maximum mark is awarded for a **correct answer on the answer line**. **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.

(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**.

Please note: Assignment of marks to the answers in all the following examples is for demonstration purposes only. Marks for actual examination questions will not necessarily follow the same pattern.

Implementation:

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

Markscheme	Candidates' Scripts	Marking
$(x-6)(x+1)$ ***(A1)(A1)***	(i) Answer line: $(x-6)(x+1)$	***(C2)***
	(ii) Answer line: $(x+6)(x+1)$	***(A0)(A1)***
	(iii) Working box: $(x-6)(x+1)$ followed by answer line: $x = 6$ and -1, or just $6,-1$	***(A1)*** ***(A0)***
	(iv) Working box: $(x-6)(x+1)$ then $x = 6,-1$ followed by answer line: $x = 6$ and -1, or just $6,-1$ or factors and roots together	***(A1)*** ***(A0)***
	but	
	(v) Working box: $(x-6)(x+1)$ then $x = 6,-1$ followed by answer line: $(x-6)(x+1)$ only	***(C2)***
	(vi) Working box: $(x-6)(x+1)$ then $x = 6,-1$ and answer line empty	***(A1)(A0)***

Question: Using Pythagoras to find a side of a triangle:

Markscheme	Candidates' Scripts	Marking
$\sqrt{9+4} = \sqrt{13}$ ***(M1)(A1)*** (3.61 3sf)	(i) Answer line: $\sqrt{13}$ or 3.61 or both	***(C2)***
	(ii) Working box: $\sqrt{9+4} = \sqrt{13} = 6.50$ Answer line 6.5	***(M1)*** ***(A0)***
	(iii) Working box: $\sqrt{9+4} = \sqrt{13} = 6.50$ Answer line empty	***(M1)(A0)***
	(iv) Working box: $\sqrt{9+4} = \sqrt{13} = 3.61$ but answer line 3.16	***(M1)(A1)*** *(obvious transcription error)*
	For further considerations on this problem with regard to accuracy see later examples.	

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

Markscheme	Candidates' Scripts	Marking
$\frac{9-3}{0-5}=-\frac{6}{5}$ ***(M1)(A1)***	(i) Working: $m=\frac{9-3}{0-5}=-\frac{6}{5}$ followed by $y=-6x/5+9$ but $-6/5$ on answer line	***(C2)***
	(ii) Working box: $m=\frac{9-3}{0-5}=-\frac{6}{5}$ followed by $y=-6x/5+9$ and then answer line: either $y=-6x/5+9$ **or** $y=-6x/5$ or nothing at all on the answer line	***(M1)*** ***(A0)*** (even if $-6/5$ is **also** on the answer line)

3 Follow through (ft) Marks

Errors made at any step of a solution can 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)'** appended to the eligible mark(s).

- If an answer resulting from follow through is extremely unrealistic (*e.g.* negative distances or wrong by large order of magnitude) then the final ***A*** mark should not be awarded. If in doubt, contact your team leader.

- If a question is transformed by an error into a **different**, **much simpler question** then follow through might not apply or might be reduced. In this situation consult your team leader and record the decision on the candidate's script.

- To award follow through marks for a question part, **there must be working present for that part** and not just an answer based on the follow through. An isolated follow through answer, with no working, must be regarded as incorrect and receives no marks **even if it seems approximately correct**.

- Inadvertent use of radians will be penalised the first time it occurs. Subsequent use, even in later questions, will normally be allowed follow through marks, unless the answer is unrealistic. Cases of this kind will be addressed on an individual basis.

Implementation: The following examples illustrate correct use of the **follow through** process in straightforward situations.

Question: An investment problem with two different rates of interest and a total amount of \$600 split across the rates in consecutive periods:

Markscheme	Candidate's Script	Marking
(a) \$ 600 × 1.02 ***(M1)*** = \$ 612 ***(A1)*** (b) \$ $(\frac{612}{2} \times 1.02) + (\frac{612}{2} \times 1.04)$ ***(M1)*** = \$ 630.36 ***(A1)*****(ft)** ***Note: The (M1) is for splitting the value from (a) and forming a sum of products.*** Here the **(ft)** indicates a possible follow through from part (a).	Case (i) (a) Final amount after 1st period = \$ 600 × 1.02 = \$ 602 (b) Amount after 2nd period = 301 × 1.02 + 301 × 1.04 = \$ 620.06 but note Case (ii) an ***(M0)*** almost always prohibits the **associated (ft)** so (a) \$ 600 × 1.02 = \$ 602 (b) \$ 602 × 1.04 = \$626.08 Case (iii) (a) \$ 600 × 1.02 = \$ 602 (b) No working. 620.06 on answer line.	***(M1)*** ***(A0)*** ***(M1)*** ***(A1)*****(ft)** ***(M1)(A0)*** ***(M0)(A0)*****(ft)** ***(M1)(A0)*** ***(M0)(A0)*****(ft)**

Question: Finding angles and lengths using trigonometry

Markscheme	Candidate's Script	Marking
(a) $\frac{\sin A}{3} = \frac{\sin 30}{4}$ ***(M1)(A1)*** $A = 22.0^\circ$ ***(A1)*** (b) $x = 7 \tan A$ ***(M1)*** = 2.83 ***(A1)*****(ft)**	(a) $\frac{\sin A}{4} = \frac{\sin 30}{3}$ $A = 41.8^\circ$ (b) case (i) $x = 7 \tan A$ = 6.26 ***but*** case (ii) 6.26	***(M1) (A0) (use of sine rule but with wrong values)*** ***(A0)*** *(Note: the 2nd* ***(A1)*** *here was not marked* **(ft)** *and cannot be awarded because there was an earlier error in the same question part.)* ***(M1)*** ***(A1)*****(ft)** ***(C0)*****(ft)**

4 Using the Markscheme

This markscheme presents a particular way in which each question might be worked and how it should be marked.

(a) As ***A*** marks are normally **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, unless otherwise instructed in the markscheme. (See the first example above). Similarly ***(A1)(R0)*** cannot be awarded for an answer which is accidentally correct for the wrong reasons given.

Implementation: Question: (a) χ^2 calculated followed by (b) degrees of freedom found and (c) and (d) comparison to critical value. (Interdependence of ***A*** and ***R*** marks.)

Markscheme	Candidate's Script	Marking
(a) $\chi_{calc}^2 = 3.92$ ***(A1)***	Case (i) (a) $\chi_{calc}^2 = 3.92$	***(A1)***
(b) $n = 4$ ***(A1)***	(b) $n = 4$	***(A1)***
(c) $\chi_{crit}^2 = 9.488$ ***(A1)*(ft)**	(c) Don't know?	***(A0)***
(d) Do not reject null hypothesis ***(A1)*(ft)** because $\chi_{calc}^2 < \chi_{crit}^2$ ***(R1)*(ft)**	(d) Do not reject null hypothesis because $\chi_{calc}^2 > 0$	***(A0)*** ***(R0)***
	Case (ii) (a) $\chi_{calc}^2 = 3.92$	***(A1)*** ***(A1)***
	(b) $n = 4$	***(A0)***
	(c) $\chi_{crit}^2 = 4.488$	***(A1)*(ft)*** ***(R1)*(ft)***
	(d) Do not reject null hypothesis because $\chi_{calc}^2 < \chi_{crit}^2$	
	Case (iii) (a) $\chi_{calc}^2 = 3.92$	***(A1)*** ***(A0)***
	(b) $n = 1$	***(A1)*(ft)***
	(c) $\chi_{crit}^2 = 3.841$	***(A1)*(ft)*** ***(R1)*(ft)***
	(d) Reject null hypothesis because $\chi_{calc}^2 > \chi_{crit}^2$	

(b) **Alternative methods** have not always been included. Thus, if an answer is wrong then the working must be carefully analysed in order that marks are awarded for a different method in a manner that is consistent with the markscheme.
Where alternative methods for complete questions are included in the markscheme, they are indicated by '**OR'** *etc*. This includes alternatives obtained with a graphic display calculator.

Example: Question to find the coordinates of a vertex of a given quadratic

Working	Marks
$f(x) = 2x^2 + 7x - 3$	
$x = -\frac{b}{2a} = -\frac{7}{4}$ ***(M1)*** *for use of –b/2a,* ***(A1)*** *for correct answer*	***(M1)(A1)***
$f(-7/4) = -\frac{146}{16} = -\frac{73}{8}$ ***(M1)*** *for using f(–7/4),* ***(A1)*** *for answer.*	***(M1)(A1)*(ft)**
Coordinates are (–7/4, –73/8)	***(A1)*(ft)**
OR	**OR**
$f'(x) = 4x + 7$, $4x+7 = 0$ so $x = –7/4$ ***(M1)*** *for attempting to take a derivative and setting it to 0* ***(A1)*** *for answer*	***(M1)*** ***(A1)***
$f(-7/4) = -\frac{146}{16} = -\frac{73}{8}$ ***(M1)*** *for using f(–7/4),* ***(A1)*** *for answer.*	***(M1)(A1)*(ft)**
Coordinates are (–7/4, –73/8)	***(A1)*(ft)**

(c) 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.

(d) 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; $1 \cdot 7$; 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'; $\overline{A}$; A^c; $U - A$; (*A U/A.*
Different forms of logic notation: $\neg p$; p' ; $\tilde{p}$; $\overline{p}$; $\sim p$.
$p \Rightarrow q$; $p \rightarrow q$; $q \Leftarrow p$.

(e) Discretionary ***(d)*** marks: There will be rare occasions where the markscheme does not cover the work seen. In such cases, ***(d)*** should be used to indicate where an examiner has used discretion. It must be accompanied by a brief note to explain the decision made.

5 Accuracy of Answers

Unless otherwise stated in the question, all numerical answers must be given exactly or correct to 3 significant figures.
A penalty known as an **ACCURACY PENALTY** ***(AP)*** is applied if an answer is either

(i) rounded incorrectly to 3 significant figures or

(ii) rounded correctly or incorrectly to some other level of accuracy.

This penalty is applied to the **final answer** of a question part only. It applies **also** when an exact answer is incorrectly rounded.

THE ACCURACY PENALTY IS APPLIED AT MOST ONCE PER PAPER! Subsequent accuracy errors can be **ignored** and full marks awarded if all else is correct.

An accuracy penalty must be recorded in proximity to the incorrect answer as ***(A0)(AP)***.
Examiners must record the occurrence of an accuracy penalty by writing ***(AP)*** next to the relevant question total on the front of the cover sheet.

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. This is **NOT** an accuracy penalty. A mark for specified accuracy can be regarded as a **(ft)** mark regardless of an immediately preceding ***(M0)***.

Rounding of an exact answer to 3 significant figures **should be accepted if performed correctly**. If the rounding is incorrect, an accuracy penalty should be applied as detailed above. 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 **(even if exact squares)** or any rational power of an integer (*e.g.* $\sqrt{13}, 2^{2/3}, \sqrt[4]{5}, \sqrt{9}$) 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.
Answers **with no supporting working** (usually from a GDC), which are written correct to more than 3 significant figures can be awarded full marks with an ***(AP)*** then applied. When this happens, multiple
C marks can be split (*e.g.* ***(A1)(A0)(AP)*** or ***(C1)(C0)(AP)***. **Unsupported** answers with less than 3 significant figures must be deemed incorrect even if they seem approximately correct.

An accuracy penalty should not be applied to an answer that is already incorrect for some other reason.

Special cases

An answer taken directly from the IB chi squared statistical table can be given and used to the same level of accuracy as appears in the table (3 decimal places) or correct to 3 significant figures.

For judging equivalence between 3sf and use of minutes and seconds for angles, guidelines have been issued to paper setters. This problem will be dealt with on an individual basis as the need arises.

Examples: The Pythagoras example used before:

Markscheme	Candidates' Scripts	Marking
$\sqrt{9+4}=\sqrt{13}$ ***(M1)(A1)*** (3.61 3sf)	(i) Working box: nothing but answer line: 3.6 or 4	***(C0)***
	(ii) Working box: nothing but answer line: 3.60555	***(C1)(C0)(AP)***
	(iii) Working box: $\sqrt{9+4}=\sqrt{13}$ Answer line: 3.6	***(M1)*** ***(A0)(AP)***
	(iv) Working box: $\sqrt{9+4}=\sqrt{13}$ Answer line: 3.60555	***(M1)*** ***(A0)(AP)***
	(v) Working box: $\sqrt{9+4}=\sqrt{13}=3.60$	***(M1)(A0)(AP)***
	(vi) Working box: $\sqrt{9+4}=\sqrt{14}=3.74$ transferred, or not, to answer line	***(M1)(A0)***

If the question specified *e.g.* correct to 4 decimal places for the answer, then there would be one extra mark available as follows:

Markscheme	Candidates' Scripts	Marking
$\sqrt{9+4} = \sqrt{13}$ ***(M1)(A1)*** = 3.6056 (4dp) ***(A1)*(ft)**	(i) Working box: nothing but answer line: 3.606	***(C0)***
	(ii) Working box: nothing but answer line: 3.6055	***(C0)***
	(iii) Working box: $\sqrt{9+4} = \sqrt{13}$ Answer line 3.6	***(M1)(A1)*** ***(A0)***
	(iv) Working box: $\sqrt{9+4} = \sqrt{13}$ Answer line: 3.60555	***(M1)(A1)*** ***(A0)***
	(v) Working box: $\sqrt{9+4} = \sqrt{14}$ = 3.7417 whether transferred to answer line or not.	***(M1)(A0)*** ***(A1)*(ft)**
	(vi) Working box: $\sqrt{9-4} = \sqrt{5}$ = 2.2361 whether transferred to answer line or not.	***(M0)(A0)*** ***(A1)*(ft)** *Note: this is a special case, where the initial **(M0)** does not determine the final **(A0)***
	(vii) Answer line: 3.61 or 3.606 wrong answers, no working.	***(C0)***

Premature Rounding

Accuracy errors in a final answer, which result from premature rounding earlier in the same question part, should not receive an accuracy penalty. There are two situations.
If there is a mark available for a prematurely rounded answer and the rounding occurs at this stage, then the inappropriate rounding should be penalised with ***(A0)*** but the answer can then be allowed to follow through to the end of the question. If the first stage of the answer is correct but rounded further on, then it should be penalised at an appropriate place close to where it is rounded. Some discretion should be used to deny a **(ft)** mark if the rounding is very bad and the answer far from its required value.

Example: Question: sine rule used to find angle A, with angle B and side b known but side a is first calculated using Pythagoras in an adjoining triangle.

Markscheme	Candidate's Script	Marking
$a = \sqrt{25+36} = \sqrt{61}$ ***(M1)(A1)***	(i) $a = \sqrt{25+36} = \sqrt{61}$ $= 7.8$	***(M1)(A0)***
$\frac{\sin(A)}{\sqrt{61}} = \frac{\sin(32)}{5}$ ***(M1)(A1)*(ft)**	$\frac{\sin(A)}{7.8} = \frac{\sin(32)}{5}$	***(M1)(A1)*(ft)**
$A = 55.9^\circ$ ***(A1)*(ft)**	$A = 55.8^\circ$	***(A1)*(ft)**
	(ii) $a = \sqrt{25+36} = \sqrt{61}$	***(M1)(A1)***
	$\frac{\sin(A)}{7.8} = \frac{\sin(32)}{5}$	***(M1)(A0)***
	$A = 55.8^\circ$	***(A1)*(ft)**
	(iii) $a = \sqrt{25+36} = \sqrt{61}$	***(M1)(A1)***
	$\frac{\sin(A)}{7.8} = \frac{\sin(32)}{5}$	***(M1)(A0)***
	$A = \sin^{-1}(0.83) = 56.1^\circ$	***(A0)***
	(iv) $a = \sqrt{25+36} = \sqrt{61} = 8$	***(M1)(A0)***
	$\frac{\sin(A)}{8} = \frac{\sin(32)}{5}$	***(M1)(A1)*(ft)**
	$A = 58.0^\circ$	***(A0)*(ft)** *(The rounding is severe and the answer quite far from correct).*

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, but could differ in rare instances depending on the currency in question.

A penalty known as a FINANCIAL ACCURACY PENALTY ***(FP)*** is applied if an answer does not adhere to the specification in the question. This penalty is applied to the final answer of a question part only.

THE FINANCIAL ACCURACY PENALTY IS APPLIED AT MOST ONCE PER PAPER! Subsequent financial accuracy errors can be ignored and full marks awarded if all else is correct.

A financial accuracy penalty must be recorded in proximity to the incorrect answer as ***(A0)(FP)***.

Examiners must record the occurrence of a financial accuracy penalty by writing ***(FP)*** next to the relevant question total on the front cover sheet.

The financial accuracy penalty is imposed only for rounding to the wrong level of accuracy and NOT for incorrect rounding to the required number of places. The latter would incur a normal accuracy penalty ***(AP)***.

No single answer can receive two penalties. If both types of error are present then *(FP)* takes priority.

Please see the examples below.

NOTE: The financial accuracy penalty will be flagged in the markscheme at the start of each answer where it could apply, with the words "Financial accuracy penalty ***(FP)*** is applicable in this question". If this instruction is not present, then do not apply the penalty. An ***(FP)*** will also be present in the left hand column next to where it applies.

Example: A financial question demands accuracy correct to 2dp.
Prior to rounding the answer is \$231.6189

Markscheme	Candidate's Script	Marking
Financial accuracy penalty ***(FP)*** is applicable in this question		
\$231.62 ***(A1)***	\$231.62 or 231.62	***(A1)*** (No unit penalty (see section 7 below) for missing \$ symbol.)
	231.6 or 232	***(A0)(FP)*** (Correct rounding process but incorrect level.)
	231.61	***(A0)(AP)*** (Incorrect rounding process to correct level.)
	231	***(A0)(FP)*** (Both types of error occurred but ***(FP)*** takes priority.)
	231.00	***(A0)(AP)*** (It's not clear whether nearest dollar or 2dp was really intended but we interpret as 2dp rounded incorrectly.)

7 Units in answers

A penalty known as a UNIT PENALTY ***(UP)*** is applied if an answer does not include the correct units. This applies both to missing units and to incorrect units. This penalty is applied to the final answer of a question part only.

THE UNIT PENALTY IS APPLIED AT MOST ONCE PER PAPER! Subsequent unit errors can be ignored and full marks awarded if all else is correct.

A unit penalty must be recorded in proximity to the incorrect answer as ***(A0)(UP)***. Examiners must record the occurrence of a unit penalty by writing ***(UP)*** next to the relevant question total on the front cover sheet.

NOTE: The unit penalty will be flagged in the markscheme at the start of each answer where it could apply, with the words "Unit penalty ***(UP)*** is applicable in this question". If this instruction is not present, then do not apply the penalty. A ***(UP)*** will also be present in the left hand column next to where it applies.

NOTE: In this context, symbols for currency such as $ or GBP etc are not considered units. Candidates are encouraged to include them but should not be penalised if they are missing.
Missing degree symbols and percentage symbols are also not eligible for a unit penalty.

No single answer can receive two penalties. If an answer is rounded incorrectly and also has wrong or missing units, apply the accuracy penalty *(AP)* only. If the *(AP)* has already been used, such an answer is eligible for the unit penalty.

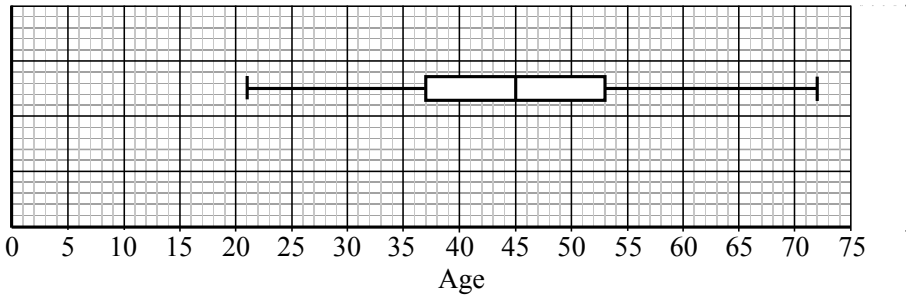
Example: A question has answer to part (i) of 66.2 cm. The answer before rounding is 66.213 cm. Part (ii) involves dividing by 60 with units cm/s. Assume that the *(UP)* has not been used previously.

Markscheme	Candidate's Script	Marking
*Unit penalty **(UP)** is applicable in this question*		
(i) 66.2 cm ***(A1)***	(i) 66.2cm	***(A1)***
(ii) 1.10 cm/s ***(A1)***	(ii) 1.10 cm/s	***(A1)***
	(i) 66.2	***(A0)(UP)***
	(ii) 1.10	***(A1)***
	(i) 66.2 cm	***(A1)***
	(ii) 1.10	***(A0)(UP)***
	(i) 66	***(A0)(AP)*** if ***(AP)*** not used previously but ***(A0)(UP)*** otherwise.
	(ii) 1.1	***(A0)(UP)*** if ***(AP)*** used in part (i) but ***(A1)*****(ft)** for correct follow through to exact answer if

	(i) 66	***(UP)*** used in part ***(A0)(AP)*** if ***(AP)*** not used previously but ***(A0)(UP)*** otherwise.
	(ii) 1.1 cm/s	***(A1)*****(ft)**

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.

Q1	(a)	29.7675 *Accept exact answer only*	***(A1)***	***(C1)***
	(b)	30	***(A1)*(ft)**	***(C1)***
	(c)	$\frac{30-29.7675}{29.7675}\times 100\,\%$ For correct formula with correct substitution.	***(M1)***	
		= 0.781 % *accept 0.78 % only if formula seen with 29.7675 as denominator*	***(A1)*(ft)**	***(C2)***
	(d)	$7.81\times10^{-1}\,\%$ (7.81×10^{-3} with no percentage sign)	***(A1)*(ft)(A1)*(ft)**	***(C2)***
				[6 marks]
Q2	(a)	Median = 45 *Accept* 45.5	***(A1)***	***(C1)***
	(b)	53 – 37 *for identifying correct quartiles*	***(A1)***	
		= 16 *for correct answer to subtraction* **(ft)** *on their quartiles*	***(A1)*(ft)**	***(C2)***
	(c)			
		Median marked correctly. Box with ends at candidate's quartiles. End points at 21 and 72 joined to box with straight lines. *Award **(A0)** if lines go right through the box.*	***(A1)*(ft)** ***(A1)*(ft)** ***(A1)***	***(C3)***
				[6 marks]
Q3	(a)	$f'(x)=6x^2-10x+3$ *Award **(A1)** for each correct term and no extra terms.* *Award **(A1)(A1)(A0)** if each term correct and extra term seen.* ***(A1)(A0)(A0)** if two terms correct and extra term seen.* *Award **(A0)** otherwise.*	***(A1)(A1)(A1)***	***(C3)***
	(b)	$f'(2)=7$	***(A1)*(ft)**	***(C1)***
	(c)	$y=7x-11$ or equivalent *Award **(A1)*(ft)** on their (b) for 7x (must have x) **(A1)*(ft)** for –11.* *Accept* $y-3=7(x-2)$.	***(A1)*(ft)(A1)*(ft)**	***(C2)***
				[6 marks]

Q4

(a) Mode = 171 ***(A1)***

Median 148, 151, 158, 163, 171, 171, 184

= 163 ***(A1)***

Mean = 64.7 ***(A1)***

Standard deviation = 13.3 ***(A1)***

If both mean and standard deviation given to 2 significant figures
Mean 65, ***(A0)(AP)***
Standard deviation 13 ***(A1)*****(ft)** *(****(AP)*** *already deducted).* ***(C4)***

(b)

19	4
20	0 5 8
21	0
22	3 6

Key 19 | 4 means 194

(A1)(A1)

(A1) *for stemplot with a key and* ***(A1)*** *for numbers in correct order.*
If key missing award ***(A0)(A1)*** *if numbers are in the correct order.* ***(C2)***

[6 marks]

Q5

(a) Choice of music is independent of age. ***(A1)*** ***(C1)***

(b) $(3 - 1)(3 - 1)$

$= 4$ ***(A1)*** ***(C1)***

(c) $\chi^2 = 51.6$ ***(A2)***

52 is an accuracy penalty ***(A1)(A0)(AP)****.* ***(C2)***

(d) *p*-value < 0.05 for 5 % level of significance ***(R1)*****(ft)**

or $51.6 > \chi^2_{crit}$

Reject the null hypothesis *(do not accept the null hypothesis)*. ***(A1)*****(ft)**

Do not award ***(R0)(A1)****.* ***(C2)***

[6 marks]

Q6

(a) Either Sean is at school or Sean is playing a game on his computer but not both. ***(A1)(A1)***

(A1) *for 'either ... or but not both'* ***(A1)*** *for correct statements.*
'Either' can be omitted. ***(C2)***

(b) If Sean is not playing a game on his computer then Sean is at school. ***(A1)(A1)***

(A1) *for 'If ... then'* ***(A1)*** *for correct propositions in the correct order.* ***(C2)***

(c)

$\neg q$	$p \Rightarrow \neg q$
F	F
T	T
F	T
T	T

(A1)(A1)**(ft)**

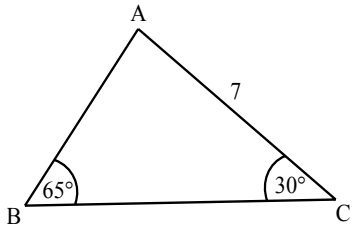
(A1) *for each correct column.* ***(C2)***

[6 marks]

Q7

*Unit penalty **(UP)** may apply in this question.*

(a)



(A1) *for fully labelled sketch.* ***(C1)***

(b) $\frac{AB}{\sin 30} = \frac{7}{\sin 65}$ ***(M1)***

AB = 3.86 cm ***(A1)*****(ft)** ***(UP)***

(M1) *for use of sine rule with correct values substituted.* ***(C2)***

(c) Angle BAC = 85° ***(A1)***

Area = $\frac{1}{2} \times 7 \times 3.86 \times \sin 85°$ ***(M1)***

= 13.5 cm^2 ***(A1)*****(ft)** ***(UP)*** ***(C3)***

[6 marks]

Q8

(a) $u_{96} = u_1 + 95d$ ***(M1)***

$= 0 + 95 \times 12$

= 1140 ***(A1)*** ***(C2)***

(b) $6r^5 = 16d$ ***(A1)***

$6r^5 = 16 \times 12$ (192) ***(A1)***

(A1) *only, if both terms seen without an equation.* ***(C2)***

(c) $r^5 = 32$ ***(A1)*****(ft)**

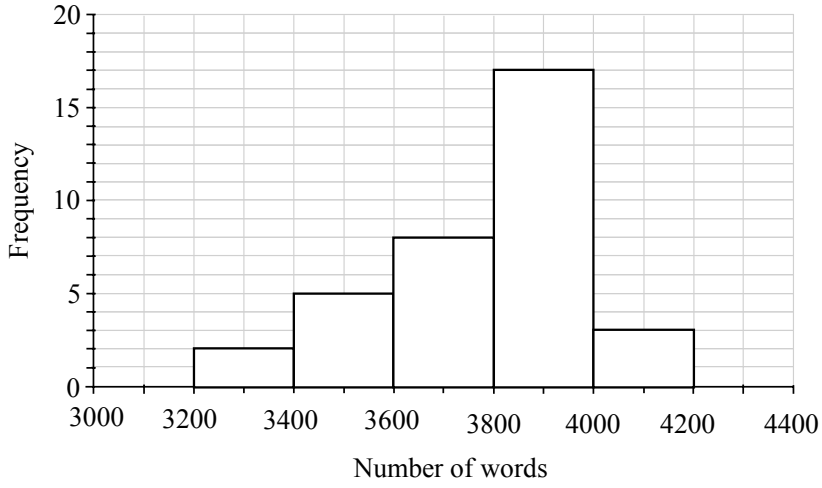
(ft) *from their (b)*

$r = 2$ ***(A1)*****(ft)** ***(C2)***

[6 marks]

Q9

(a)



(A3)

(A3) for correct histogram,
(A2) for one error, (A1) for two errors, (A0) for more than two errors.
Award maximum (A2) if lines do not appear to be drawn with a ruler.
Award maximum (A2) if a frequency polygon is drawn.

(C3)

(b) Modal group = $3800 \leq w < 4000$ ***(A1)*** ***(C1)***

(c) Probability = $\frac{3}{35}$ (0.0857, 8.57 %) ***(A1)(A1)***

(A1) for correct numerator (A1) for correct denominator.

(C2)

[6 marks]

Q10

*Financial penalty **(FP)** may apply in this question.*

(a) 1500×1.33

(FP) = 1995.00 *(accept 1995)* ***(A1)*** ***(C1)***

(b) USD left = 1995 – 1350 = 645 ***(A1)***

$= \frac{645}{1.38}$ Euros ***(A1)*(ft)**

(FP) = 467.39 Euros ***(A1)*(ft)*** ***(C3)***

(c) $\frac{645}{1.36} \times 0.992 = 470.47$ ***(A1)*(ft)***

(FP) She lost 3.08 Euros ***(A1)*(ft)***
The word 'lost' is not required.

*If candidate has divided in (a) and multiplied in (b) and (c) consistently award **(A0)(A1)(ft)(A1)(ft)** for answers of –222.18 for USD left and 306.61 Euros in (b) and **(A1)(ft)(A1)(ft)** for 299.75 and 6.86 in (c).*

(C2)

[6 marks]

Q11

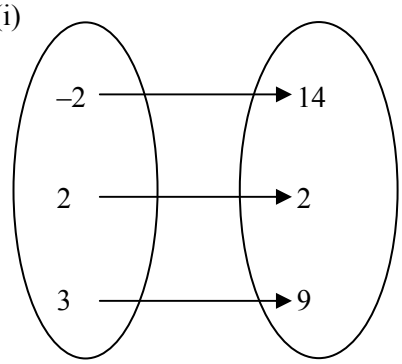
(a)

	$\mathbb{N}$	$\mathbb{Z}$	$\mathbb{Q}$	$\mathbb{R}$
2	✓	✓	✓	✓
$\sqrt{3}$	✗	✗	✗	✓
$-\frac{2}{3}$	✗	✗	✓	✓

(A1)
(A1)
(A1)

Accept any symbol for ticks.
Do not penalise if the other boxes are left blank. **(C3)**

(b) (i)



(A1)(A1)

*Award **(A1)** for structure and layout of mapping diagram,*
***(A1)** for correct values.* **(C2)**

(ii) Range = {2, 9, 14} ***(A1)*(ft)**
Brackets not required. **(C1)**

[6 marks]

Q12

*Financial penalty **(FP)** may apply in this question.*

(a) 33.09×24 ***(A1)***
***(A1)** for 33.09 seen*

(FP) = \$794.16 ***(A1)*** **(C2)**

(b) 794.16×36 ***(M1)***
For multiplying their (a) by 36. Can be implied.

(FP) = \$28 589.76 ***(A1)*(ft)** **(C2)**

(c) $\frac{10837.80}{10 \times 18}$ ***(M1)***

$= 60.21$

Rate = 5.5 % ***(A1)*** **(C2)**

[6 marks]

Q13

(a) To double, interest = 3000 ***(A1)***

$3000 = \frac{3000 \times 4 \times n}{100}$ ***(M1)***

For substituting into the simple interest formula

n = 25 years ***(A1)*****(ft)**

(A1) *for 3000 on one side of equation if not seen separately.*

For interest of 6000 award ***(M1)(A1)*****(ft)** *for answers of 50 years.* ***(C3)***

(b) $6000 = 3000\left(1 + \frac{3.5}{200}\right)^{2n}$ ***(M1)(A1)***

(M1) *for substituting values into a compound interest formula,*

(A1) *for correct values with a variable for the power.*

n = 20 years ***(A1)***

If n used in formula instead of 2n, can allow as long as final answer is halved to get 20. ***(C3)***

[6 marks]

Q14

Unit penalty ***(UP)*** *may apply in this question.*

(a) Distance = $\pi \times 500 + 2 \times 750$ ***(M1)***

(UP) = 3070 m ***(A1)*** ***(C2)***

(b) 140 kmh^{-1} = $\frac{140 \times 1000}{60 \times 60}$ ms^{-1} ***(M1)***

= 38.9 ms^{-1} ***(A1)***

Time = $\frac{3070}{38.889}$ ***(M1)***

(UP) = 78.9 seconds *(accept 79.0 seconds)* ***(A1)*****(ft)** ***(C4)***

[6 marks]

Q15

(a) a = 1800 ***(A1)*** ***(C1)***

(b) 200×3^6 (or $16\,200 \times 9$) = 145 800 ***(M1)(A1)*** ***(C2)***

(c) $200 \times 3^n = 2 \times 10^6$ (where n is each 4 hour interval) ***(M1)***

Award ***(M1)*** *for attempting to set up the equation or writing a list of numbers.*

$3^n = 10^4$

n = 8.38 (8.383613097) *correct answer only* ***(A1)***

Time = 33.5 hours *(accept 34, 35 or 36 if previous* ***A*** *mark awarded)* ***(A1)*****(ft)**

(A1)**(ft)** *for correctly multiplying their answer by 4.*

If 34, 35 or 36 seen, or 32 – 36 seen, award (M1)(A0)(A0). ***(C3)***

[6 marks]