

GCE

Mathematics A

H230/01: Pure Mathematics and Statistics

AS Level

Mark Scheme for June 2025

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This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

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MARKING INSTRUCTIONS

PREPARATION FOR MARKING RM ASSESSOR

1. Make sure that you have accessed and completed the relevant training packages for on-screen marking: *RM Assessor Online Training: OCR Essential Guide to Marking*.
2. Make sure that you have read and understood the mark scheme and the question paper for this unit. These are available in RM Assessor
3. Log-in to RM Assessor and mark the **required number** of practice responses (“scripts”) and the **required number** of standardisation responses.

MARKING

1. Mark strictly to the mark scheme.
2. Marks awarded must relate directly to the marking criteria.
3. The schedule of dates is very important. It is essential that you meet the RM Assessor 50% and 100% (traditional 40% Batch 1 and 100% Batch 2) deadlines. If you experience problems, you must contact your Team Leader (Supervisor) without delay.
4. If you are in any doubt about applying the mark scheme, consult your Team Leader by telephone, email or via the RM Assessor messaging system.
5. **Crossed-Out Responses**

Where a candidate has crossed out a response and provided a clear alternative then the crossed-out response is not marked. Where no alternative response has been provided, examiners may give candidates the benefit of the doubt and mark the crossed-out response where legible.

Rubric Error Responses – Optional Questions

Where candidates have a choice of question across a whole paper or a whole section and have provided more answers than required, then all responses are marked and the highest mark allowable within the rubric is given. Enter a mark for each question answered into RM Assessor, which will select the highest mark from those awarded. (*The underlying assumption is that the candidate has penalised themselves by attempting more questions than necessary in the time allowed.*)

Multiple-Choice Question Responses

When a multiple-choice question has only a single, correct response and a candidate provides two responses (even if one of these responses is correct), then no mark should be awarded (as it is not possible to determine which was the first response selected by the candidate).

When a question requires candidates to select more than one option/multiple options, then local marking arrangements need to ensure consistency of approach.

Contradictory Responses

When a candidate provides contradictory responses, then no mark should be awarded, even if one of the answers is correct.

Short Answer Questions (requiring only a list by way of a response, usually worth only one mark per response)

Where candidates are required to provide a set number of short answer responses then only the set number of responses should be marked. The response space should be marked from left to right on each line and then line by line until the required number of responses have been considered. The remaining responses should not then be marked. Examiners will have to apply judgement as to whether a 'second response' on a line is a development of the 'first response', rather than a separate, discrete response. *(The underlying assumption is that the candidate is attempting to hedge their bets and therefore getting undue benefit rather than engaging with the question and giving the most relevant/correct responses.)*

Short Answer Questions (requiring a more developed response, worth two or more marks)

If the candidates are required to provide a description of, say, three items or factors and four items or factors are provided, then mark on a similar basis – that is downwards (as it is unlikely in this situation that a candidate will provide more than one response in each section of the response space).

Longer Answer Questions (requiring a developed response)

Where candidates have provided two (or more) responses to a medium or high tariff question which only required a single (developed) response and not crossed out the first response, then only the first response should be marked. Examiners will need to apply professional judgement as to whether the second (or a subsequent) response is a 'new start' or simply a poorly expressed continuation of the first response.

6. Always check the pages (and additional objects if present) at the end of the response in case any answers have been continued there. If the candidate has continued an answer there, then add the annotation 'SEEN' to confirm that the work has been seen and mark any responses using the annotations in section 11.
7. There is a NR (**No Response**) option. Award NR (No Response):
 - if there is nothing written at all in the answer space

- OR if there is a comment which does not in any way relate to the question (e.g., 'can't do', 'don't know')
- OR if there is a mark (e.g., a dash, a question mark) which is not an attempt at the question.

Note: Award 0 marks – for an attempt that earns no credit (including copying out the question).

8. The RM Assessor **comments box** is used by your Team Leader to explain the marking of the practice responses. Please refer to these comments when checking your practice responses. **Do not use the comments box for any other reason.**
9. *Assistant Examiners will send a brief report on the performance of candidates to their Team Leader (Supervisor) via email by the end of the marking period. The report should contain notes on particular strengths displayed as well as common errors or weaknesses. Constructive criticism of the question paper/mark scheme is also appreciated.*
10. For answers marked by levels of response: Not applicable in F501
To determine the level – start at the highest level and work down until you reach the level that matches the answer
To determine the mark within the level, consider the following

Descriptor	Award mark
On the borderline of this level and the one below	At bottom of level
Just enough achievement on balance for this level	Above bottom and either below middle or at middle of level (depending on number of marks available)
Meets the criteria but with some slight inconsistency	Above middle and either below top of level or at middle of level (depending on number of marks available)
Consistently meets the criteria for this level	At top of level

11. Annotations

Annotation	Meaning
✓ and ✕	
BOD	Benefit of doubt
FT	Follow through
ISW	Ignore subsequent working
M0, M1	Method mark awarded 0, 1
A0, A1	Accuracy mark awarded 0, 1
B0, B1	Independent mark awarded 0, 1
E	Explanation mark 1
SC	Special case
^	Omission sign
MR	Misread
BP	Blank Page
Seen	
Highlighting	

Other abbreviations in mark scheme	Meaning
dep*	Mark dependent on a previous mark, indicated by *. The * may be omitted if only one previous M mark
cao	Correct answer only
oe	Or equivalent
rot	Rounded or truncated
soi	Seen or implied
www	Without wrong working
AG	Answer given
awrt	Anything which rounds to
BC	By Calculator
DR	This question included the instruction: In this question you must show detailed reasoning.

Subject Specific Marking Instructions

- a. Annotations must be used during your marking. For a response awarded zero (or full) marks a single appropriate annotation (cross, tick, M0 or ^) is sufficient, but not required.

For responses that are not awarded either 0 or full marks, you must make it clear how you have arrived at the mark you have awarded and all responses must have enough annotation for a reviewer to decide if the mark awarded is correct without having to mark it independently.

It is vital that you annotate standardisation scripts fully to show how the marks have been awarded.

Award NR (No Response)

- if there is nothing written at all in the answer space and no attempt elsewhere in the script
- OR if there is a comment which does not in any way relate to the question (e.g. 'can't do', 'don't know')
- OR if there is a mark (e.g. a dash, a question mark, a picture) which isn't an attempt at the question.

Note: Award 0 marks only for an attempt that earns no credit (including copying out the question).

If a candidate uses the answer space for one question to answer another, for example using the space for 8(b) to answer 8(a), then give benefit of doubt unless it is ambiguous for which part it is intended.

- b. An element of professional judgement is required in the marking of any written paper. Remember that the mark scheme is designed to assist in marking incorrect solutions. Correct solutions leading to correct answers are awarded full marks but work must not always be judged on the answer alone, and answers that are given in the question, especially, must be validly obtained; key steps in the working must always be looked at and anything unfamiliar must be investigated thoroughly. Correct but unfamiliar or unexpected methods are often signalled by a correct result following an apparently incorrect method. Such work must be carefully assessed. When a candidate adopts a method which does not correspond to the mark scheme, escalate the question to your Team Leader who will decide on a course of action with the Principal Examiner.

If you are in any doubt whatsoever you should contact your Team Leader.

- c. The following types of marks are available.

M

A suitable method has been selected and applied in a manner which shows that the method is essentially understood. Method marks are not usually lost for numerical errors, algebraic slips or errors in units. However, it is not usually sufficient for a candidate just to indicate an intention of using some method or just to quote a formula; the formula or idea must be applied to the specific problem in hand, e.g. by substituting the relevant quantities into the formula. In some cases the nature of the errors allowed for the award of an M mark may be specified.

A method mark may usually be implied by a correct answer unless the question includes the DR statement, the command words “Determine” or “Show that”, or some other indication that the method must be given explicitly.

A

Accuracy mark, awarded for a correct answer or intermediate step correctly obtained. Accuracy marks cannot be given unless the associated Method mark is earned (or implied). Therefore M0 A1 cannot ever be awarded.

B

Mark for a correct result or statement independent of Method marks.

E

A given result is to be established or a result has to be explained. This usually requires more working or explanation than the establishment of an unknown result.

Unless otherwise indicated, marks once gained cannot subsequently be lost, e.g. wrong working following a correct form of answer is ignored. Sometimes this is reinforced in the mark scheme by the abbreviation isw. However, this would not apply to a case where a candidate passes through the correct answer as part of a wrong argument.

- d. When a part of a question has two or more ‘method’ steps, the M marks are in principle independent unless the scheme specifically says otherwise; and similarly where there are several B marks allocated. (The notation ‘dep*’ is used to indicate that a particular mark is dependent on an earlier, asterisked, mark in the scheme.) Of course, in practice it may happen that when a candidate has once gone wrong in a part of a question, the work from there on is worthless so that no more marks can sensibly be given. On the other hand, when two or more steps are successfully run together by the candidate, the earlier marks are implied and full credit must be given.
- e. The abbreviation FT implies that the A or B mark indicated is allowed for work correctly following on from previously incorrect results. Otherwise, A and B marks are given for correct work only – differences in notation are of course permitted. A (accuracy) marks are not given for answers obtained from incorrect working. When A or B marks are awarded for work at an intermediate stage of a solution, there

may be various alternatives that are equally acceptable. In such cases, what is acceptable will be detailed in the mark scheme. If this is not the case please, escalate the question to your Team Leader who will decide on a course of action with the Principal Examiner.

Sometimes the answer to one part of a question is used in a later part of the same question. In this case, A marks will often be 'follow through'. In such cases you must ensure that you refer back to the answer of the previous part question even if this is not shown within the image zone. You may find it easier to mark follow through questions candidate-by-candidate rather than question-by-question.

- f. We are usually quite flexible about the accuracy to which the final answer is expressed; over-specification is usually only penalised where the scheme explicitly says so.
- When a value is given in the paper only accept an answer correct to at least as many significant figures as the given value.
 - When a value is not given in the paper accept any answer that agrees with the correct value to 3 s.f. unless a different level of accuracy has been asked for in the question, or the mark scheme specifies an acceptable range.
- NB for Specification B (MEI) the rubric is not specific about the level of accuracy required, so this statement reads "2 s.f".

Follow through should be used so that only one mark in any question is lost for each distinct accuracy error.

Candidates using a value of 9.80, 9.81 or 10 for g should usually be penalised for any final accuracy marks which do not agree to the value found with 9.8 which is given in the rubric.

- g. Rules for replaced work and multiple attempts:
- If one attempt is clearly indicated as the one to mark, or only one is left uncrossed out, then mark that attempt and ignore the others.
 - If more than one attempt is left not crossed out, then mark the last attempt unless it only repeats part of the first attempt or is substantially less complete.
 - if a candidate crosses out all of their attempts, the assessor should attempt to mark the crossed out answer(s) as above and award marks appropriately.
- h. For a genuine misreading (of numbers or symbols) which is such that the object and the difficulty of the question remain unaltered, mark according to the scheme but following through from the candidate's data. A penalty is then applied; 1 mark is generally appropriate, though this may differ for some units. This is achieved by withholding one A or B mark in the question. Marks designated as cao may be awarded as long as there are no other errors.
- If a candidate corrects the misread in a later part, do not continue to follow through. E marks are lost unless, by chance, the given results are established by equivalent working. Note that a miscopy of the candidate's own working is not a misread but an accuracy error.

- i. If a calculator is used, some answers may be obtained with little or no working visible. Allow full marks for correct answers, provided that there is nothing in the wording of the question specifying that analytical methods are required such as the bold “In this question you must show detailed reasoning”, or the command words “Show” or “Determine”. Where an answer is wrong but there is some evidence of method, allow appropriate method marks. Wrong answers with no supporting method score zero. If in doubt, consult your Team Leader.
- j. If in any case the scheme operates with considerable unfairness consult your Team Leader.

Question			Answer	Mark	AO	Guidance
1	(a)		DR $x^2 - 11 = 25$ $[x^2 = 36] \Rightarrow x = \pm 6$	M1 A1 [2]	1.1 1.1	Square both sides
1	(b)		DR $(y^3)^2 + 7y^3 - 8 = 0$ or $u = y^3$ $(y^3 + 8)(y^3 - 1) = 0$ or $(u + 8)(u - 1) = 0$ $y^3 = -8$ or 1 or $u = -8$ or 1 $y = -2$ or 1	M1 B1 A1 A1 [4]	1.1 1.1 1.1 1.1	soi (implied by B1) Allow other letters but not $y = y^3$ Correct working or use of formula to solve a quadratic in u, y^3 oe. Condone omission of $= 0$ and sign errors for this mark (NB answers only without working scores 0/4)
1	(c)		DR $3z - 10 = 4$ $z = \frac{14}{3}$ or 4.67 (3sf)	M1 A1 [2]	1.1 1.1	May see additional earlier working including logs or 2^{10} etc. but award M1 for a correct linear equation in z only. Allow alternative forms e.g. $3z - 10 = \log_2 16$ but must be a linear equation in z

Question			Answer	Mark	AO	Guidance
2			$\frac{ax^3}{3} - x^2 + 4x$	M1	3.1a	Attempt to integrate; ≥ 2 terms correct. Ignore any limits for this mark.
			$\left[\frac{ax^3}{3} - x^2 + 4x\right]_0^5 = \frac{125a}{3} - 25 + 20 \quad [-0 = 45]$	M1	1.1	Substitute limits 5 and 0 into their integral (i.e. any cubic and not the quadratic given), 0 may be implied
			$[125a = 150] \Rightarrow a = \frac{6}{5} \text{ or } 1.2$	A1 [3]	1.1	

Question			Answer	Mark	AO	Guidance
3	(a)		$(x - 3)^2 - 9$	M1 A1 [2]	1.1 1.1	M1 for $(x - 3)^2 \pm k$ or $(x + 3)^2 - 9$ A1 for all correct
3	(b)		$(x - 3)^2 - 9 + y^2 - 16 = 0$ $(x - 3)^2 + (y - 0)^2 = 25$ or $(x - 3)^2 + y^2 = 25$ Centre (3, 0), radius = 5	M1 A1FT A1 [3]	1.1 1.1 1.1	oe, substituting their completed square form - FT their (a) FT their (a) – must see constant terms combined cao

Question			Answer	Mark	AO	Guidance
4	(a)		$\text{LHS} \equiv \frac{\cos^2 \theta - (1 - \sin \theta)}{(1 - \sin \theta) \cos \theta}$ $\equiv \frac{-\sin^2 \theta + \sin \theta}{(1 - \sin \theta) \cos \theta}$ $\equiv \frac{\sin \theta (1 - \sin \theta)}{(1 - \sin \theta) \cos \theta} \equiv \frac{\sin \theta}{\cos \theta} \equiv \tan \theta \text{ AG}$	M1*	3.1a	Collect over common denominator. Allow sign error.
				M1 dep*	1.1	Use of $\sin^2 \theta + \cos^2 \theta \equiv 1$ so that the numerator is in $\sin \theta$ only. Allow sign error in numerator.
				A1	2.1	Correct completion to AG www
			Alternative method 1: $\frac{\cos^2 \theta}{(1 - \sin \theta) \cos \theta} - \frac{1}{\cos \theta} \equiv \frac{(1 - \sin^2 \theta)}{(1 - \sin \theta) \cos \theta} - \frac{1}{\cos \theta}$ $\equiv \frac{(1 - \sin \theta)(1 + \sin \theta)}{(1 - \sin \theta) \cos \theta} - \frac{1}{\cos \theta}$ $\equiv \frac{1 + \sin \theta}{\cos \theta} - \frac{1}{\cos \theta} \equiv \frac{\sin \theta}{\cos \theta} \equiv \tan \theta \text{ AG}$	M1*		Multiply first term by $\frac{\cos \theta}{\cos \theta}$ and use $\sin^2 \theta + \cos^2 \theta \equiv 1$ so that the numerator is in $\sin \theta$ only.
4	(b)			M1 dep*		Using difference of two squares in first term.
				A1		Correct completion to AG www
			Alternative method 2: $\frac{\cos \theta (1 + \sin \theta)}{(1 - \sin \theta)(1 + \sin \theta)} - \frac{1}{\cos \theta} \left[\equiv \frac{\cos \theta (1 + \sin \theta)}{1 - \sin^2 \theta} - \frac{1}{\cos \theta} \right]$ $\equiv \frac{\cos \theta + \cos \theta \sin \theta}{\cos^2 \theta} - \frac{1}{\cos \theta} \left[\equiv \frac{1 + \sin \theta}{\cos \theta} - \frac{1}{\cos \theta} \right]$ $\equiv \frac{1 + \sin \theta - 1}{\cos \theta} \equiv \frac{\sin \theta}{\cos \theta} \equiv \tan \theta \text{ AG}$	M1*		Multiply first term by $\frac{1 + \sin \theta}{1 + \sin \theta}$
				M1 dep*		Use of $\sin^2 \theta + \cos^2 \theta \equiv 1$ so that the denominator is in $\cos \theta$ only.
4	(b)			A1		Correct completion to AG www
				[3]		May see variations on each method and/or equivalent work done to both sides of identity in ‘parallel’ – mark to either method above as each step appears.
			$\tan 3x = 1$ $\tan^{-1}(1)$ $[3x =] 45^\circ \text{ or } 225^\circ$ $x = 15^\circ \text{ or } 75^\circ$	B1	3.1a	soi
				M1	1.1	soi, eg by 45° seen
4	(b)			A1	1.1	Both, ignore extras (may be implied by final A1)
				A1	1.1	Both, no extras
				[4]		

Question			Answer	Mark	AO	Guidance
5	(a)		${}^9C_7 \times 2^7 \times 3^2$ or $36 \times 128 \times 9$ oe $= 41472$	M1 A1 [2]	1.1 1.1	May be implied by answer, allow use of 9C_2 Condone $41472x^7$ but not $41472x^2$
5	(b)	(i)	x^{10} and x^{11} or 10 and 11	B1 [1]	3.1a	Allow ${}^{21}C_{10}x^{10}$ and ${}^{21}C_{11}x^{11}$ oe
5	(b)	(ii)	$21 - r = r + 5$ or $r + r + 5 = 21$ or $r = \frac{21}{2} - 2\frac{1}{2}$ $r = 8$	M1 A1	2.1 1.1	May be implied by answer
			Alternative method 1 $\frac{21}{2} = 10.5$, hence terms are symmetrical about 10.5 [11 – 10 = 1, 12 – 9 = 3] 13 – 8 = 5, hence $r = 8$	M1 A1		oe soi
			Alternative method 2 ${}^{21}C_r = {}^{21}C_{r+5} = \frac{21!}{r!(21-r)!} = \frac{21!}{(r+5)!(21-(r+5))!}$ $(r+5)(r+4)(r+3)(r+2)(r+1)$ $= (21-r)(20-r)(19-r)(18-r)(17-r)$ e.g. $21 - r = r + 5$ or $17 - r = r + 1$ $r = 8$	M1 A1		No mark for this line unless correct answer is seen. May be implied by the correct answer.
			Alternative method 3 ${}^{21}C_8 = {}^{21}C_{13} = 203490$ $r = 8$	M1 A1		Both seen (trial and improvement). May be implied by A1.
				[2]		

Question		Answer	Mark	AO	Guidance
6	(a)	DR $\log_3(x + 32) - \log_3 x - \log_3 2 + \log_3 2 = 2$ $\log_3\left(\frac{x + 32}{x}\right) = 2$	M1 M1	3.1a 2.1	Correct use of $\log(ab) = \log a + \log b$ Correct use of $\log\left(\frac{a}{b}\right) = \log a - \log b$ These first two M marks may appear in either order.
		Alternative method for M1M1: $\log_3\left(\frac{2(x + 32)}{2x}\right) = 2$	M2		Must see ‘handling’ of 2 in numerator and denominator to award these marks in one step (e.g. writing and cancelling)
		$\frac{x + 32}{x} = 9 \text{ or } 3^2$ $x = 4$	M1 A1	1.1 1.1	Correctly remove logs from their equation Dependent on all 3 method marks.
		Alternative method: $\log_3\left(\frac{x+32}{2x}\right) + \log_3 2 = 2$ $\log_3\left(\frac{x+32}{2x}\right) = 2 - \log_3 2$ $\frac{x+32}{2x} = 3^{2-\log_3 2} \left[= \frac{3^2}{3^{\log_3 2}} \right]$ $\frac{x+32}{2x} = \frac{9}{2} [= 4.5] \text{ or } \frac{x+32}{x} = 9$ $x = 4$	M1 M1 A1		Correct use of $\log\left(\frac{a}{b}\right) = \log a - \log b$ Correctly remove logs from all terms involving x Correctly evaluate and remove all remaining logs Dependent on all 3 method marks.
			[4]		NB candidates who do not show ‘handling’ of the terms in $\log_3 2$ can score max. 2/4
6	(b)	DR $y^{-\frac{3}{2}} = \frac{1}{8} \text{ oe}$ $y = \left(\frac{1}{8}\right)^{-\frac{2}{3}} \text{ or } y = \sqrt[3]{\frac{1}{8}}$ or $y^{\frac{3}{2}} = 8 \Rightarrow y = 8^{\frac{2}{3}}$ $y = 4$	M1 M1 A1 [3]	1.1 2.1 1.1	Correctly removing log. Manipulate to solvable form - must be correct for their equation. An intermediate step must be seen (between first M1 and solution) otherwise M1M0A0. www

Question			Answer	Mark	AO	Guidance
7	(a)		DR $\overrightarrow{OP} = \mathbf{a} + \overrightarrow{AP}$ or $\mathbf{c} + \mathbf{a} + \overrightarrow{BP}$ $\overrightarrow{OP} = \mathbf{a} + \frac{1}{3}\mathbf{c}$ $\overrightarrow{OQ} = \frac{3}{4}\overrightarrow{OP} = \frac{3}{4}\left(\mathbf{a} + \frac{1}{3}\mathbf{c}\right)$ $= \frac{3}{4}\mathbf{a} + \frac{1}{4}\mathbf{c}$ AG	M1 A1 M1 A1 [4]	3.1a 1.1 1.1 1.1	soi If labelled then must be correctly identified as $\overrightarrow{OP}$ Use of $\overrightarrow{OQ} = \frac{3}{4}\overrightarrow{OP}$ with their $\overrightarrow{OP}$ soi, may use $\overrightarrow{OQ} = 3\overrightarrow{QP}$ Must see an intermediate step, as a minimum $\frac{3}{4}\left(\mathbf{a} + \frac{1}{3}\mathbf{c}\right)$ oe
7	(b)		DR $\overrightarrow{AQ} = \frac{3}{4}\mathbf{a} + \frac{1}{4}\mathbf{c} - \mathbf{a} \left[= \frac{1}{4}\mathbf{c} - \frac{1}{4}\mathbf{a}\right]$ $[\overrightarrow{AC} = \mathbf{c} - \mathbf{a}]$ $\Rightarrow \overrightarrow{AQ} = \frac{1}{4}\overrightarrow{AC}$ or $\overrightarrow{AC}$ is a [scalar] multiple of $\overrightarrow{AQ}$ or $\overrightarrow{AQ}$ is parallel to $\overrightarrow{AC}$ or $\overrightarrow{AC} = 4\overrightarrow{AQ}$ Hence Q lies on AC AG	M1 A1 A1	1.1 2.1 2.2a	Or $\overrightarrow{QC} [= -\overrightarrow{OQ} + \overrightarrow{OC}] = -\frac{3}{4}\mathbf{a} - \frac{1}{4}\mathbf{c} + \mathbf{c} \left[= \frac{3}{4}\mathbf{c} - \frac{3}{4}\mathbf{a}\right]$ oe, e.g. $\overrightarrow{QC} = \frac{3}{4}\overrightarrow{AC}$ may see ' Q, A, C colinear' but must be justified. Correct conclusion, dep $\overrightarrow{AQ} = \frac{1}{4}\overrightarrow{AC}$ oe seen www Other methods may be seen, e.g. using $\overrightarrow{CQ}$ or $\overrightarrow{QA}$
			Alternative method $\frac{3}{4}\mathbf{a} + \frac{1}{4}\mathbf{c}$ is of the form $\alpha\mathbf{a} + (1 - \alpha)\mathbf{c}$ Hence Q lies on AC	M2 A1 [3]		

Question			Answer	Mark	AO	Guidance
8			$\frac{dy}{dx} = 3x^2 + 6x - 9$	M1*	3.1a	Attempt differentiate; ≥ 2 terms correct
			$3x^2 + 6x - 9 = 0$	M1 dep*	1.1	Their $\frac{dy}{dx} = 0$, may be implied by A1FT
			$x = -3$ or 1	A1FT	1.1	FT their $\frac{dy}{dx} = 0$ (must be a quadratic with two roots)
			$y = 15$ or -17	A1FT	1.1	FT their x -values (must have two values)
			Gradient $= \frac{15 - (-17)}{-3 - 1}$ oe	M1	2.1	FT their coordinates (if correct then value is -8)
			$y - 15 = -8(x + 3)$ or $y + 17 = -8(x - 1)$ or $y = -8x + c$ with (x, y) substituted	M1**	1.1	Correct method for equation, FT gradient and coordinates ($c = -9$)
			$-15 = -8(x + 3)$ or $17 = -8(x - 1)$ or $0 = -8x - 9$	M1 dep**	1.1	Substitute $y = 0$ into their AB . May be implied by answer
			Meets x -axis at $\left(-\frac{9}{8}, 0\right)$	A1 [8]	1.1	Allow $(-1.125, 0)$ but must be given as coordinates.

Question			Answer	Mark	AO	Guidance
9	(a)		[Fairly good] negative correlation [between time spent on hobbies and mark in test].	B1	2.2b	oe e.g. ‘more hours spent on games, lower marks on test’ Condone causal implications e.g. ‘leads to’ or ‘causes’
			except for one point	B1	2.4	or with one outlier (condone ‘anomaly’ or ‘an outlier’) These two distinct comments required – do not accept repetition of either
				[2]		
9	(b)		There may be a third factor affecting both time spent on hobbies and marks in the test	B1	2.4	Accept e.g.: • ‘there may be other factors affecting both’ B1 • Any possible third factor (with example) B1 Do not accept e.g.: • ‘not enough data’ B0 • ‘more hours gaming leads to less sleep/revision which impacts score’ B0 (suggesting causal mechanism rather than different explanation) • ‘students are spending more time playing games than revising’ B0
			or (e.g.) “the more able students may have been away last week, so they didn’t spend much time playing computer games”			
9	(c)		Median = 26 IQR = 13	B1	1.1	(May be seen in (d))
				B1 [2]	1.1	
9	(d)		Marks: $[33 + 1.5 \times 13 =]$ 52.5 $[20 - 1.5 \times 13 =]$ 0.5 Hours: $[20 + 1.5 \times 17 =]$ 45.5 $[3 - 1.5 \times 17 =]$ – 22.5 No outliers	B1FT [1]	3.1a	Must see use of $1.5 \times \text{IQR}$ at least twice: sight of 52.5 (FT), and 45.5 . FT IQR (for marks) and quartiles from (c) (NB do not accept 45.5 from $26 + 1.5 \times 13$) Correct conclusion FT their values.

9	(e)		The outlier in the diagram is an outlier with regard to the correlation , not the marks or number of hours	B1FT	2.3	oe, FT their conclusion from (d) e.g. if conclude in (d) that there are ≥ 2 outliers then the comment here should be ‘there is more than one outlier’ and/or ‘there are outliers, but not at this location’ because ‘they are outliers with regard to the marks or hours, not the overall correlation’ Must give an explanation, not just ‘there is not actually an outlier’ Must refer to ‘pattern’, ‘relationship’ or ‘correlation’ oe
				[1]		

Question			Answer	Mark	AO	Guidance
10	(a)		Liverpool	B1*	2.2b	
			Smaller population but similar number of UMLRT users	B1 dep* [2]	2.4	Accept e.g. ‘same numerator, smaller denominator’ Accept use of estimated values from graph e.g. comparing ~3/800 for Birmingham vs ~3/525 for Liverpool. May be rounded but must be plausible.
10	(b)		Demands on trains and/or infrastructure are more affected by passenger numbers [than proportions, so do not agree]	B1 [1]	2.4	Accept valid statements in context e.g.: • ‘what matters to planners is the number of people who are going to use the infrastructure’ B1 • ‘more people mean more public transport is needed, regardless of proportion’ B1 Do not accept generic statements about number and proportion or unrelated reasons e.g.: • ‘small increase in number could be substantial increase in proportion’ B0 • ‘non-employees may also use UMLRT service’ B0
10	(c)		E.g. Greater proportion means that the message is getting across	B1	2.2b	Two distinct points in context from: • ‘greater proportion of people in employment using public transport is good’ • ‘these campaigners would want the proportion of people using UMLRT to be the same or greater’ • ‘the overall population size is more important’
			E.g. But matters more in larger areas so unclear	B1 [2]	2.2b	• ‘some areas are more suited to UMLRT than others’ • ‘No as they may wish to achieve more use of public transport overall’ • ‘Higher proportion using UMLRT means a smaller proportion using cars, which is what the group want to achieve’

10	(d)	Those who live outside those LAs but who [nevertheless] use the system are not included.	B1	2.4	Oe but must be a comment about the data used (i.e. not the graphs) e.g. • ‘The data will include everyone in an LA even if there is just one transit station [i.e. the whole population may not be served by UMLRT]’ B1 • ‘Employees may use UMLRT stations in neighbouring LAs’ B1 Do not accept generic statements e.g.: • ‘data does not include size of each region’ B0 • unless justified in the context of the question e.g. ‘data may include people who live in an LA where there is a UMLRT station but it is very far away’ B1 • ‘LAs without UMLRT stations will not be included’ B0 • ‘LAs may not contain UMLRT stations in each region’ [misunderstanding of $LA \subseteq \text{region}$] B0 • ‘London not included’ B0 • ‘does not account for other public transport e.g. buses’ B0
			[1]		

Question			Answer	Mark	AO	Guidance
11			$P(\text{win}) = \frac{3}{8} \cdot \frac{1}{3} + \frac{3}{8} \cdot \frac{1}{3} + \left(\frac{1}{6}\right)^2 + \frac{1}{6} \cdot \frac{1}{3} + \frac{1}{6} \cdot \frac{1}{3} + \left(\frac{1}{3}\right)^2$	M1	3.1a	M1 for ≥ 3 correct product terms soi
			A1	A1	3.4	For all 6 product terms (and no others)
			Alternative for M1A1: $P(\text{lose}) = \left(\frac{1}{8}\right)^2 + 2 \cdot \frac{1}{8} \cdot \frac{3}{8} + 2 \cdot \frac{1}{8} \cdot \frac{1}{6} + 2 \cdot \frac{1}{8} \cdot \frac{1}{3} + \left(\frac{3}{8}\right)^2 + 2 \cdot \frac{3}{8} \cdot \frac{1}{6}$	M1		M1 for ≥ 3 correct product terms soi
			A1	A1		For all 10 product terms (and no others)
			$[P(\text{score} > 5) =][P(\text{score} \leq 5) =]\frac{1}{2}$	A1	1.1	
			Zayn is incorrect. Winning and not winning are equally likely oe	A1FT	3.2a	Must conclude whether Zayn is correct/incorrect. FT their probability (any value in $[0,1]$) e.g.: - If $P(\text{score} > 5) > \frac{1}{2} \Rightarrow$ Zayn is correct - If $P(\text{score} > 5) < \frac{1}{2} \Rightarrow$ Zayn is incorrect Allow this mark even if $P(\text{win}) + P(\text{lose}) \neq 1$ for: $P(\text{win}) > P(\text{lose}) \Rightarrow$ Zayn is correct $P(\text{win}) < P(\text{lose}) \Rightarrow$ Zayn is incorrect
				[4]		

Question		Answer	Mark	AO	Guidance
12	(a)	$H_0: p = \frac{1}{3}$ where $p = P(\text{student buys canteen lunch})$ $H_1: p > \frac{1}{3}$	B1 B1	1.1 2.5	Accept proportion, allow 'where p is the proportion who buy canteen lunch' Undefined p : B1B0 No use of parameter: B0B0 Subtract B1 for each error e.g.: 2-tail B1B0 - undefined p B1B0 - use of X, x and not defined B0B0 - not in terms of parameter B1B0 p = sample proportion implied B1B0 - Not include value $\frac{1}{3}$ B0B0 $H_0 = \frac{1}{3}$ etc: B0B0 Allow 0.33333 recurring Treat as B1B1 with -1 for each error
12	(b)	$X \sim B\left(552, \frac{1}{3}\right)$ and $X = 200$ or 201 so $P(X \geq 201) = 1 - P(X \leq 200) = \mathbf{0.0689}$ $0.0689 > 0.05$ Do not reject H_0 Insufficient evidence that proportion buying lunch in the canteen has increased	M1 A1 A1FT M1 A1	3.3 3.4 1.1 1.1 2.2b	Correct distribution and value of X , both may be stated or implied e.g. by 0.0689 ($X \geq 201$) even if within incorrect statement e.g. $P(X = 201) = 0.0689$. BC allow 2sf (0.069) Correct for '0.0689', FT hypotheses and condone 5% M1 dep $P(X \geq 201$ or $200)$ stated or calculated, i.e. 0.0689 or 0.0578 from $P(X > 201)$ - seen Condone "Accept H_0 " but not "Reject H_1 " In context, not definite, e.g. not "Proportion who buy lunch in the canteen is $\frac{1}{3}$ " or "is the same" Accept "insufficient evidence to support governors' claim" but not just "governors are wrong" www (dependent on all previous marks except first A1, provided their probability is 0.06 or 0.07 to 1sf) A0 for 'number' of students

12	(c)		Last day of term may not be typical	B1 [1]	3.5b	Accept equivalents e.g.: • ‘The day of the test was not chosen at random’ B1 Condone e.g.: • ‘this was based on a single day’s data’ B1 • ‘not every student may have been at school on the last day of term’ B1
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