CAMBRIDGE
International Education

Cambridge International AS & A Level

MATHEMATICS **9709/65**

Paper 6 Probability & Statistics 2 **May/June 2025**

MARK SCHEME

Maximum Mark: 50

Published

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge International will not enter into discussions about these mark schemes.

Cambridge International is publishing the mark schemes for the May/June 2025 series for most Cambridge IGCSE, Cambridge International A and AS Level components, and some Cambridge O Level components.

This document consists of **14** printed pages.

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Generic Marking Principles

These general marking principles must be applied by all examiners when marking candidate answers. They should be applied alongside the specific content of the mark scheme or generic level descriptions for a question. Each question paper and mark scheme will also comply with these marking principles.

GENERIC MARKING PRINCIPLE 1:
Marks must be awarded in line with:

- the specific content of the mark scheme or the generic level descriptors for the question
- the specific skills defined in the mark scheme or in the generic level descriptors for the question
- the standard of response required by a candidate as exemplified by the standardisation scripts.

GENERIC MARKING PRINCIPLE 2:
Marks awarded are always **whole marks** (not half marks, or other fractions).

GENERIC MARKING PRINCIPLE 3:
Marks must be awarded **positively**:

- marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate
- marks are awarded when candidates clearly demonstrate what they know and can do
- marks are not deducted for errors
- marks are not deducted for omissions
- answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.

GENERIC MARKING PRINCIPLE 4:
Rules must be applied consistently, e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

GENERIC MARKING PRINCIPLE 5:
Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).

GENERIC MARKING PRINCIPLE 6:
Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

Mathematics-Specific Marking Principles

1 Unless a particular method has been specified in the question, full marks may be awarded for any correct method. However, if a calculation is required then no marks will be awarded for a scale drawing.

2 Unless specified in the question, non-integer answers may be given as fractions, decimals or in standard form. Ignore superfluous zeros, provided that the degree of accuracy is not affected.

3 Allow alternative conventions for notation if used consistently throughout the paper, e.g. commas being used as decimal points.

4 Unless otherwise indicated, marks once gained cannot subsequently be lost, e.g. wrong working following a correct form of answer is ignored (isw).

5 Where a candidate has misread a number or sign in the question and used that value consistently throughout, provided that number does not alter the difficulty or the method required, award all marks earned and deduct just 1 A or B mark for the misread.

6 Recovery within working is allowed, e.g. a notation error in the working where the following line of working makes the candidate's intent clear.

Annotations guidance for centres

Examiners use a system of annotations as a shorthand for communicating their marking decisions to one another. Examiners are trained during the standardisation process on how and when to use annotations. The purpose of annotations is to inform the standardisation and monitoring processes and guide the supervising examiners when they are checking the work of examiners within their team. The meaning of annotations and how they are used is specific to each component and is understood by all examiners who mark the component.

We publish annotations in our mark schemes to help centres understand the annotations they may see on copies of scripts. Note that there may not be a direct correlation between the number of annotations on a script and the mark awarded. Similarly, the use of an annotation may not be an indication of the quality of the response.

The annotations listed below were available to examiners marking this component in this series.

Annotations

Annotation	Meaning
	More information required
	Accuracy mark awarded zero
	Accuracy mark awarded one
	Independent accuracy mark awarded zero
	Independent accuracy mark awarded one
	Independent accuracy mark awarded two
	Benefit of the doubt
	Blank Page
	Incorrect
Dep	Used to indicate DM0 or DM1

Annotation	Meaning
DM1	Dependent on the previous M1 mark(s)
FT	Follow through
~~	Indicate working that is right or wrong
Highlighter	Highlight a key point in the working
ISW	Ignore subsequent work
J	Judgement
JU	Judgement
M0	Method mark awarded zero
M1	Method mark awarded one
M2	Method mark awarded two
MR	Misread
O	Omission or Other solution
Off-page comment	Allows comments to be entered at the bottom of the RM marking window and then displayed when the associated question item is navigated to.
On-page comment	Allows comments to be entered in speech bubbles on the candidate response.
PE	Judgment made by the PE
Pre	Premature approximation
SC	Special case
SEEN	Indicates that work/page has been seen

Annotation	Meaning
SF	Error in number of significant figures
✓	Correct
TE	Transcription error
XP	Correct answer from incorrect working

Question	Answer	Marks	Guidance
1(a)	$\lambda = 4.5$	**B1**	SOI.
	$e^{-4.5}(1 + 4.5 + \frac{4.5^2}{2!} + \frac{4.5^3}{3!}) = e^{-4.5}(1 + 4.5 + 10.125 + 15.1875)$ $= 0.01111 + 0.04999 + 0.11248 + 0.16872$	**M1**	Allow any λ; allow one end error; expression or terms must be seen.
	= 0.342 (3 sf)	**A1**	**SC** Unsupported answer of 0.342 scores **B1**.
		3	
1(b)	$P(S \leqslant 1) = e^{-4.5}(1 + 4.5)$ or $5.5e^{-4.5}$ or $P(S \leqslant 2) = e^{-4.5}(1 + 4.5 + \frac{4.5^2}{2})$ or $\frac{125}{8}e^{-4.5}$	**M1**	For either expression. Allow any λ, allow one end error.
	$P(S \leqslant 2) \div P(S \leqslant 1)$ [$= \frac{125}{8} \div 5.5$]	**M1**	Both expressions. No end error, $\lambda = 4.5$. Division attempted. Allow in decimal form for this mark.
	$\frac{P(S \leq 2)}{P(S \leq 1)} = \frac{125}{44}$	**A1**	**AG**. Must be exact, not decimal approximation. No decimals seen (condone exact decimals). Convincingly obtained, $1 + 4.5$ and $1 + 4.5 + \frac{4.5^2}{2}$ evaluated.
		3	

Question	Answer	Marks	Guidance
2(a)	Unbiased estimate of mean of $x = 2 + \frac{60}{200} = 2.3$	**B1**	Can be given at an early stage.
	Unbiased estimate of variance of $(x-2) = \frac{200}{199}\left(\frac{20}{200} - '0.3'^2\right)$ or $\frac{1}{199}\left(20 - \frac{60^2}{200}\right)$	**M1**	Biased estimate scores **M0**. Accept use of $\Sigma(x-\bar{x})^2$ correctly substituted.
	$0.01005... = 0.0101$ (3 s.f.) or $\frac{2}{199}$	**A1**	Condone 0.01, from unbiased estimate.
	CI for x is '2.3' $\pm z \times \sqrt{\frac{'0.01005'}{200}}$	**M1**	**FT** their mean and variance. Must be a z value (note: if only one side of the interval still allow **M1**).
	$z = 1.96$	**B1**	Seen.
	CI for x is 2.29 to 2.31 (3 sf)	**A1**	Must be an interval. **SC** Use of biased variance (0.01) can score **A1FT** max 4/6.
		6	
2(b)	Use of z = '1.96', or Value of z used [comes from normal distribution].	**B1**	Must refer to z (i.e. 'value of z' or '1.96'). Not "X not normally distributed". Not "Assume that $\bar{X}$ is normally distributed".
		1	

Question	Answer	Marks	Guidance
3(a)	342	**B1**	Only.
		1	
3(b)(i)	0.798, 0.799	**B1**	Only.
		1	
3(b)(ii)	0.998	**B1**	Only.
		1	
3(c)	680 and 850 are not equally likely to be chosen for the sample.	**B1**	Or a sample including 680 is more likely to be selected than a sample including 850. Must relate to part **(b)**. Allow **FT** if number of solutions in **(i)** and **(ii)** are different.
		1	

Question	Answer	Marks	Guidance
4(a)	$1 - e^{-4}(1 + 4 + \frac{4^2}{2!} + \frac{4^3}{3!})$ $1 - e^{-4}\left(1 + 4 + 8 + \frac{32}{3}\right)$ $= 1 - (0.018316 + 0.073263 + 0.14653 + 0.19537)$ [= 0.56653]	**M1**	Any λ. Allow one end error. Must see full expression or terms.
	$1 - e^{-2.5}(1 + 2.5) = 1 - (0.08208 + 0.20521)$ [= 0.71270]	**M1**	Any λ. Allow one end error. Must see full expression or terms.
	'0.56653' × '0.71270'	**M1**	Multiply *their* values.
	= 0.404 (3 sf)	**A1**	**SC$_1$** Unsupported answer of 0.404 scores **B3**. **SC$_2$** Unsupported 0.567 and 0.713 scores **B1**, leading to **M1A1** as per scheme.
		4	
4(b)	$\lambda = 156$	**B1**	
	N(156, 156)	**B1FT**	Seen or implied.
	$\frac{144.5 - '156'}{\sqrt{'156'}}$ [= –0.921]	**M1**	For standardising with their values. Allow with wrong or no cc.
	Φ('–0.921') = 1 – Φ('0.921')	**M1**	Finding the area consistent with their value.
	= 0.179 or 0.178 (3 sf)	**A1**	
		5	

Question	Answer	Marks	Guidance
5	E(F) = 140.2	**B1**	
	Var(F) = $4 \times 3.8^2 + 6.1^2$ [= 94.97]	**M1**	Must be a combination of 3.8 and 6.1.
	$\frac{143-'140.2'}{\sqrt{\frac{'94.97'}{25}}}$ (= 1.437) or $\frac{143+\frac{1}{50}-'140.2'}{\sqrt{\frac{'94.97'}{25}}}$ [= 1.447]	**M1**	For standardising with their values. Must have $\sqrt{25}$. Allow incorrect continuity correction.
	1 – Φ('1.437') or 1 – Φ('1.447')	**M1**	Finding the area consistent with their value. Allow attempted continuity correction
	= 0.0754 (3 sf) or = 0.0739 or 0.0740 (3 sf)	**A1**	Allow 0.074.
		5	

Question	Answer	Marks	Guidance
6(a)	H_0: $p = 0.28$ H_1: $p < 0.28$	**B1**	
	P($X \leq 4$) = $0.72^{30} + 30\times0.72^{29}\times0.28 + {}^{30}C_2\times0.72^{28}\times0.28^2 + {}^{30}C_3\times0.72^{27}\times0.28^3 + {}^{30}C_4\times0.72^{26}\times0.28^4$ $= 0.0000525 + 0.0006122 + 0.0034524 + 0.012531 + 0.03893$	**M1**	For attempting to find $P(X \leq 4)$ using $B(30, 0.28)$, no end errors. Expression or terms must be seen.
	= 0.0495 (3 sf)	**A1**	**SC** 0.0495, no working: **B1**.
	'0.0495' < 0.1	**M1**	Valid comparison of *their* 0.0495 (must be a tail probability) with 0.1.
	[Reject H_0] There is sufficient evidence [at 10% level] to suggest that the percentage [who support Forward Now] is less than 28%.	**A1FT**	**FT** *their* 0.0495. No contradictions, in context, not definite.
		5	

Question	Answer	Marks	Guidance
6(b)	Yes, because H_0 was rejected.	**B1FT**	OE. **FT** their conclusion from **6(a)**.
		1	
6(c)	P($X \leqslant 5$) = 0.116 (3 sf)	**B1**	
	P(Type I) = 0.0495	**B1**	
		2	

Question	Answer	Marks	Guidance
7(a)	H_0: Population mean (or μ) = 12 H_1: Population mean (or μ) < 12	**B1**	Accept population mean, but not just mean.
		1	
7(b)	$\frac{11.4-12}{2.3\div\sqrt{50}}$ [= –1.845]	**M1**	For standardising. Must have $\sqrt{50}$.
	–1.845 < –1.645 or 1.845 > 1.645 or 0.0325 < 0.05 [Hence H_0 is rejected]	**A1**	OE. Correct comparison seen. No contradictions.
		2	

Question	Answer	Marks	Guidance
7(c)	1 – Φ('1.845') [= 0.0325 3 sf]	**M1**	Or P(X < 11.4) = 0.0325 or 3.25% (3 sf). May be implied.
	$\alpha > 3.25$ (3 sf)	**A1**	Or $\alpha \geqslant 3.25$ (3 sf). Allow $\alpha > 3$ with correct working. 0.0325 scores **M1A0**. Condone 3.25%.
		2	

Question	Answer	Marks	Guidance
8(a)	$\frac{1}{2} \times \sqrt{2} \times k\sqrt{2} = \frac{1}{2}$ or $\int_0^{\sqrt{2}} kx\,dx = \frac{1}{2}$	**M1**	Using the median =0.5. Must attempt integration for 'or' method. Correct limits and = 0.5 for 'or' method. For a method involving k and a, **M0** until a is evaluated.
	$k = \frac{1}{2}$	**A1**	
		2	

Question	Answer	Marks	Guidance
8(b)	$\frac{1}{2} \times a \times \frac{1}{2} a = 1$ or $\int_0^a \frac{1}{2} x \mathrm{d}x = 1$	**M1**	**FT** their k.
	$a = 2$	**A1FT**	**FT** their k. Can be seen in **8(a)**.
	$\int_0^2 \frac{1}{2} x^2 \mathrm{d}x$ $\left[= \left[\frac{x^3}{6}\right]_0^2\right]$	**M1**	Attempt to integrate $x \times$ (their k)x, limits 0 to their a. Allow $\int_0^a kx^2 \mathrm{d}x$ with integration attempted.
	$= \frac{4}{3}$ or 1.33 (3 sf)	**A1**	
		4	