Cambridge Assessment International Education

Cambridge International A Level

MATHEMATICS **9709/53**

Paper 5 Probability & Statistics 1 **October/November 2020**

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.

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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 descriptors 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.

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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, 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 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 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.

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Mark Scheme Notes

The following notes are intended to aid interpretation of mark schemes in general, but individual mark schemes may include marks awarded for specific reasons outside the scope of these notes.

Types of mark

M Method mark, awarded for a valid method applied to the problem. Method marks are not 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. Correct application of a formula without the formula being quoted obviously earns the M mark and in some cases an M mark can be implied from a correct answer.

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).

B Mark for a correct result or statement independent of method marks.

DM or **DB** When a part of a question has two or more "method" steps, the M marks are generally independent unless the scheme specifically says otherwise; and similarly, when there are several B marks allocated. The notation DM or DB is used to indicate that a particular M or B mark is dependent on an earlier M or B (asterisked) mark in the scheme. When two or more steps are run together by the candidate, the earlier marks are implied and full credit is given.

FT Implies that the A or B mark indicated is allowed for work correctly following on from previously incorrect results. Otherwise, A or B marks are given for correct work only.

- A or B marks are given for correct work only (not for results obtained from incorrect working) unless follow through is allowed (see abbreviation FT above).
- For a numerical answer, allow the A or B mark if the answer is correct to 3 significant figures or would be correct to 3 significant figures if rounded (1 decimal place for angles in degrees).
- The total number of marks available for each question is shown at the bottom of the Marks column.
- Wrong or missing units in an answer should not result in loss of marks unless the guidance indicates otherwise.
- Square brackets [ ] around text or numbers show extra information not needed for the mark to be awarded.

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Abbreviations

AEF/OE	Any Equivalent Form (of answer is equally acceptable) / Or Equivalent
AG	Answer Given on the question paper (so extra checking is needed to ensure that the detailed working leading to the result is valid)
CAO	Correct Answer Only (emphasising that no 'follow through' from a previous error is allowed)
CWO	Correct Working Only
ISW	Ignore Subsequent Working
SOI	Seen Or Implied
SC	Special Case (detailing the mark to be given for a specific wrong solution, or a case where some standard marking practice is to be varied in the light of a particular circumstance)
WWW	Without Wrong Working
AWRT	Answer Which Rounds To

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Question	Answer	Marks	Guidance
1(a)	$P(56 < X < 66) = P\left(\frac{56-62}{5} < z < \frac{66-62}{5}\right)$ $= P(-1.2 < z < 0.8)$	**M1**	Using ± standardisation formula at least once, no $\sqrt{\sigma}$ or σ^2, allow continuity correction
	$\Phi(0.8) + \Phi(1.2) - 1$ $= 0.7881 + 0.8849 - 1$	**M1**	Appropriate area Φ, from standardisation formula in final solution
	0.673	**A1**	
		3	
1(b)	$z = 1.127$	**B1**	±(1.126 – 1.127) seen, 4 sf or more
	$\frac{60t-62}{5} = 1.127$ $60t = 5.635+62=67.635$	**M1**	z-value = $\pm\frac{(60t-62)}{5}$ condone z-value = $\pm\frac{(t-62)}{5}$ no continuity correction, condone $\sqrt{\sigma}$ or σ^2
	$t = 1.13$	**A1**	CAO
		3	

Question	Answer	Marks	Guidance
2(a)	$\left(\frac{5}{6}\right)^8$	**M1**	p^8, $0 < p < 1$, no x, + or -
	0.233	**A1**	
		2	
2(b)	36	**B1**	
		1	
2(c)	$P(X=10) + P(X=11) = \left(\frac{35}{36}\right)^9 \frac{1}{36} + \left(\frac{35}{36}\right)^{10} \frac{1}{36}$	**M1**	OE, unsimplified expression in form $p^9q + p^{10}q$, $p + q = 1$, no $\times$
	0.0425	**A1**	
		2	

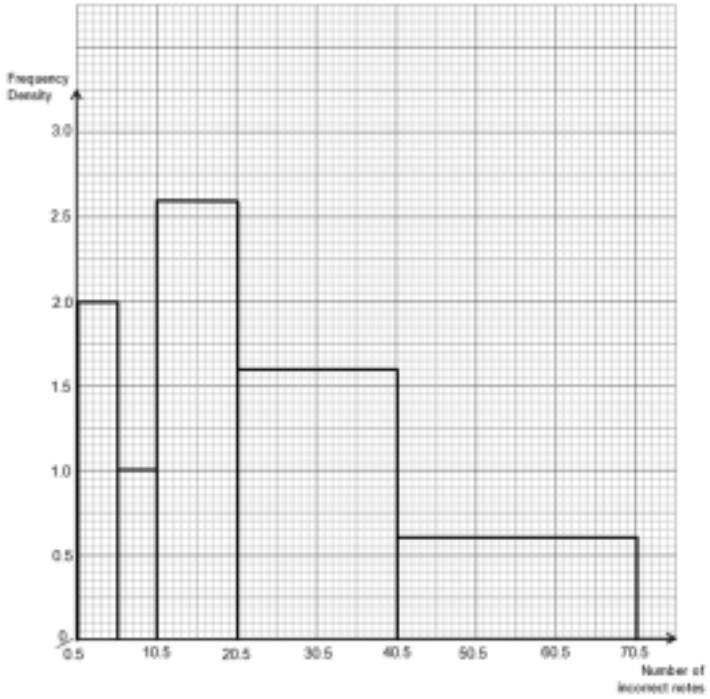
Question	Answer	Marks	Guidance
3(a)	Scenarios: 6W 0M ${}^{9}C_{6} = 84$ 5W 1M ${}^{9}C_{5} \times {}^{5}C_{1} = 126 \times 5 = 630$ 4W 2M ${}^{9}C_{4} \times {}^{5}C_{2} = 126 \times 10 = 1260$	**M1**	Correct number of ways for either 5 or 4 women, accept unsimplified
		M1	Summing the number of ways for 2 or 3 correct scenarios (can be unsimplified), no incorrect scenarios.
	Total = 1974	**A1**	
		3	
3(b)	Total number of ways = ${}^{14}C_{6}$ (3003) Number with sister and brother = ${}^{12}C_{4}$ (495) Number required = ${}^{14}C_{6}$ –	**M1**	${}^{14}C_{6}$ – a value
	${}^{12}C_{4} = 3003 - 495$	**M1**	${}^{12}C_{x}$ or ${}^{n}C_{4}$ seen on its own or subtracted from *their* total, $x \leqslant 6$, $n \leqslant 13$
	2508	**A1**	
	Alternative method for question 3(b)		
	Number of ways with neither = ${}^{12}C_{6} = 924$	**M1**	${}^{12}C_{6}$ + a value
	Number of ways with either brother or sister (not both) = ${}^{12}C_{5} \times 2$ (= 792×2) = 1584	**M1**	${}^{12}C_{x} \times 2$ or ${}^{n}C_{5} \times 2$ seen on its own or added to *their* number of ways with neither, $x \leqslant 5$, $n \leqslant 12$
	Number required = 924 + 1584 = 2508	**A1**	
		3	

Question	Answer	Marks	Guidance
4(a)	$0.65^7 + {}^7C_1\ 0.65^6\ 0.35^1 + {}^7C_2\ 0.65^5\ 0.35^2$	**M1**	Binomial term of form ${}^7C_x\ p^x(1-p)^{7-x}$, $0 < p < 1$, any p, $x \neq 0, 7$
	0.049022 + 0.184776 + 0.29848	**A1**	Correct unsimplified answer
	0.532	**A1**	
		3	
4(b)	Mean = $142 \times 0.35 = 49.7$ Variance = $142 \times 0.35 \times 0.65 = 32.305$	**B1**	Correct unsimplified *np* and *npq* (condone $\sigma = 5.684$ evaluated)
	$P(X > 40) = P(z > \frac{40.5 - 49.7}{\sqrt{32.305}})$	**M1**	Substituting *their* μ *and* σ (no $\sqrt{\sigma}$ or σ^2) into ±standardisation formula with a numerical value for '40.5'
	$P(z > -1.619)$	**M1**	Using either 40.5 or 39.5 within a ±standardisation formula
		M1	Appropriate area Φ, from standardisation formula $P(z > \ldots)$ in final solution, must be probability
	0.947	**A1**	Correct final answer
		5	

Question	Answer	Marks	Guidance
5(a)	Total number of ways = $\frac{8!}{3!2!}$ (= 3360)	**B1**	Correct unsimplified expression for total number of ways
	Number of ways with V and E in correct positions = $\frac{6!}{2!\times 2!}$ (= 180)	**B1**	$\frac{6!}{2!\times 2!}$ alone or as numerator in an attempt to find the number of ways with V and E in correct positions. No $\times, \pm$
	Probability = $\frac{180}{3360}$ $\left(=\frac{3}{56}\right)$ or 0.0536	**B1 FT**	Final answer from *their* $\frac{6!}{2!\times 2!}$ divided by *their* total number of ways
	Alternative method for question 5(a)		
	$\frac{1}{8}\times\frac{3}{7}$	**M1**	$\frac{a}{8}\times\frac{b}{7}$ seen, no other terms (correct denominators)
		M1	$\frac{1}{c}\times\frac{3}{d}$ seen, no other terms (correct numerators)
	$\frac{3}{56}$ or 0.0536	**A1**	
		3	

Question	Answer	Marks	Guidance
5(b)	Rs together and Es together: 5! (120)	**B1**	Alone or as numerator of probability to represent the number of ways with Rs and Es together, no ×, +, –
	Es together: $\frac{6!}{2!}(=360)$	**B1**	Alone or as denominator of probability to represent the number of ways with Es together, no ×, + or –
	Probability = $\dfrac{\frac{5!}{6!}}{\frac{2!}{}}$	**M1**	$\dfrac{\textit{their}\,5!}{\textit{their}\,\frac{6!}{2!}}$ seen
	$\frac{1}{3}$	**A1**	OE
	Alternative method for question 5(b)		
	P(Rs together and Es together): $\dfrac{5!}{\textit{their}\text{ total number of ways}}\left(=\frac{1}{28}\right)$	**B1**	
	P(Es together): $\dfrac{\frac{6!}{2!}}{\textit{their}\text{ total number of ways}}\left(=\frac{3}{28}\right)$	**B1**	Alone or as numerator of probability to represent the P(Rs and Es together), no ×, +, –
	Probability = $\dfrac{\frac{1}{28}}{\frac{3}{28}}$	**M1**	Alone or as denominator of probability to represent the P(Es together), no ×, + or –
	$\frac{1}{3}$	**A1**	OE, $\dfrac{\textit{their}\,\frac{1}{28}}{\textit{their}\,\frac{3}{28}}$ seen
		4	

Question	Answer	Marks	Guidance
6(a)	Scenarios: HHT: $\frac{2}{3}\times\frac{2}{3}\times\frac{1}{5}=\frac{4}{45}$ HTH: $\frac{2}{3}\times\frac{1}{3}\times\frac{4}{5}=\frac{8}{45}$ THH: $\frac{1}{3}\times\frac{2}{3}\times\frac{4}{5}=\frac{8}{45}$	**M1**	One 3 factor probability with 3, 3, 5 as denominators
		M1	3 factor probabilities for 2 or 3 correct scenarios added, no incorrect scenarios
	Total = $\frac{20}{45}=\frac{4}{9}$	**A1**	AG, Total of 3 products with clear context
		3	
6(b)	x: 0, 1, 2, 3 Prob.: $\frac{1}{45}$, $\frac{8}{45}$, $\frac{20}{45}$, $\frac{16}{45}$	**B1**	Probability distribution table with correct outcomes with at least one probability, allow extra outcome values if probability of zero stated'
		B1	2 of P(0), P(1) and P(3) correct
		B1 FT	3 or 4 probabilities sum to 1 with P(2) correct
		3	
6(c)	$\text{Var(X)} = \frac{0^2\times1+1^2\times8+2^2\times20+3^2\times16}{45}-\left(\frac{32}{15}\right)^2$ $= \frac{8}{45}+\frac{80}{45}+\frac{144}{45}-\left(\frac{32}{15}\right)^2$	**M1**	Substitute *their* attempts at scores in correct variance formula, must have '– mean^2' (FT if calculated) (condone probs not summing to 1); must be at least 2 non-zero values
	$\frac{136}{225}$ or 0.604	**A1**	
		2	

Question	Answer	Marks	Guidance
7(a)	Class widths: 5, 5, 10, 20, 30 Frequency density: 2, 1, 2.6, 1.6, 0.6	**M1**	At least 3 class widths correct and used in a calculation
		M1	At least 3 correct frequency densities unsimplified – FT *their* class widths
		**A1**	All correct heights on a histogram using a linear vertical scale from zero – no FT
		B1	Correct upper bar ends (5.5, 10.5, 20.5, 40.5, 70.5) and 4 correct lower bar ends of 5.5, 10.5, 20.5, 40.5. Condone 0 or 1.
		B1	Linear scales with at least 3 values indicated on each axis, vertical scale from 0, axes labelled 'fd' and 'no. of (incorrect) notes', or better.
		5	
7(b)	LQ: 11 – 20 UQ: 21 – 40	**B1**	Both UQ and LQ correct
	Greatest IQR = 40 – 11 = 29	**B1 FT**	Subtract lower end of *their* LQ interval from upper end of *their* UQ interval
		2	

Question	Answer	Marks	Guidance
7(c)	Midpoints: 3 8 15.5 30.5 55.5	**M1**	At least 4 midpoints correct and used
	Mean $= \frac{3\times10+8\times5+15.5\times26+30.5\times32+55.5\times18}{91}$ $= \frac{30+40+403+976+999}{91}$ $= \frac{2448}{91}$	**M1**	Correct formula with *their* midpoints (not upper boundary, lower boundary, class width, frequency density, frequency or cumulative frequency)
	$26.9,\ 26\frac{82}{91}$	**A1**	Accept 26 or 27
		3	