

Cambridge International AS & A Level

MATHEMATICS**9709/51**

Paper 5 Probability & Statistics 1

October/November 2024**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 October/November 2024 series for most Cambridge IGCSE, Cambridge International A and AS Level components, and some Cambridge O Level components.

This document consists of **16** printed pages.

PUBLISHED**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.

PUBLISHED**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.

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

PUBLISHED

Question	Answer	Marks	Guidance
1(a)	Method 1		
	$[P(X < 8) =] 1 - \left(\frac{5}{6}\right)^7$	M1	$1 - b^d, b = \frac{5}{6}, \frac{1}{6} \quad d = 7, 8.$ $1 - c^e - (1 - c) \times c^{e-1}, c = \frac{5}{6}, \frac{1}{6} \quad e = 8, 9.$
	= 0.721	A1	0.720918... $\frac{201811}{279936}$. If M0 scored, SC B1 for 0.7209... or $\frac{201811}{279936}$ only.
	Method 2		
	$[P(X < 8) =] \frac{1}{6} + \left(\frac{5}{6}\right)\left(\frac{1}{6}\right) + \left(\frac{5}{6}\right)^2\left(\frac{1}{6}\right) + \left(\frac{5}{6}\right)^3\left(\frac{1}{6}\right) + \left(\frac{5}{6}\right)^4\left(\frac{1}{6}\right) + \left(\frac{5}{6}\right)^5\left(\frac{1}{6}\right) + \left(\frac{5}{6}\right)^6\left(\frac{1}{6}\right)$	M1	$a + ba + b^2a + b^3a + b^4a + b^5a + b^6a [+ b^7a] .$ $a = \frac{1}{6}, \frac{5}{6} \quad a + b = 1.$
	= 0.721	A1	0.720918... $\frac{201811}{279936}$. If M0 scored, SC B1 for 0.7209... or $\frac{201811}{279936}$ only.
		2	

PUBLISHED

Question	Answer	Marks	Guidance
1(b)	$\left(\frac{5}{6}\right)^6 \times \left(\frac{1}{6}\right)^2 \times 7$	M1	$\left(\frac{5}{6}\right)^6 \times \left(\frac{1}{6}\right)^2 \times d$ d an integer ≥ 1 , no inappropriate addition.
	0.0651	A1	$0.0651 \leq p < 0.06512$.
		2	

Question	Answer	Marks	Guidance												
2(a)	[Probs $6k, 3k, 2k, 6k, 11k$ so $28k = 1$,] $k = \frac{1}{28}$	B1	k must be identified												
	<table><tr><td>x</td><td>-2</td><td>-1</td><td>0</td><td>2</td><td>3</td></tr><tr><td>$P(X = x)$</td><td>$\frac{6}{28}$ 0.2143</td><td>$\frac{3}{28}$ 0.1071</td><td>$\frac{2}{28}$ 0.07143</td><td>$\frac{6}{28}$ 0.2143</td><td>$\frac{11}{28}$ 0.3929</td></tr></table>	x	-2	-1	0	2	3	$P(X = x)$	$\frac{6}{28}$ 0.2143	$\frac{3}{28}$ 0.1071	$\frac{2}{28}$ 0.07143	$\frac{6}{28}$ 0.2143	$\frac{11}{28}$ 0.3929	M1	Table with correct outcomes and 2 correct probabilities. FT substituting <i>their</i> k correctly into formula, with $0 < p < 1$. No additional x values unless probability 0. Condone in terms of k of the form $\frac{6k}{28}$ or $6k$.
	x	-2	-1	0	2	3									
	$P(X = x)$	$\frac{6}{28}$ 0.2143	$\frac{3}{28}$ 0.1071	$\frac{2}{28}$ 0.07143	$\frac{6}{28}$ 0.2143	$\frac{11}{28}$ 0.3929									
		A1	Fully correct. Decimal answers to at least 3 sig figures, condone not summing exactly to 1.												
		3													

PUBLISHED

Question	Answer	Marks	Guidance
2(b)	$E(X) = \left[-2 \times \frac{6}{28} + -1 \times \frac{3}{28} + \left[0 \times \frac{2}{28} \right] + 2 \times \frac{6}{28} + 3 \times \frac{11}{28} \right]$ $\frac{1}{28}(-12 - 3 + 12 + 33) \left[= \frac{15}{14} \right]$	M1	Accept unsimplified expression. May be calculated in the variance. FT <i>their</i> table with 5 probabilities $0 < p < 1$ that sum to 1.
	$\text{Var}(X) = \frac{6 \times (-2)^2 + 3 \times (-1)^2 + 6 \times 2^2 + 11 \times 3^2}{28}$ $- \text{their} \left(\frac{15}{14} \right)^2$	M1	Appropriate variance formula using <i>their</i> $(E(X))^2$ value. FT <i>their</i> table with at least 4 probabilities $0 < p < 1$, that may not sum to 1.
	$= 4.21, 4 \frac{41}{196}$	A1	Condone $\frac{825}{196}$. If one or both M marks not awarded, SC B1 for correct answer WWW.
		3	

PUBLISHED

Question	Answer	Marks	Guidance
3(a)		M1	At least 4 points plotted within tolerance at upper bounds. Linear cf scale $0 \leq cf \leq 200$ and linear time scale $0 \leq t \leq 70$, with at least 3 values identified on each. Minimum scale uses at least $\frac{1}{2}$ the grid.
		A1	All points plotted correctly. Curve drawn and joined to (0, 0). Axes labelled cumulative frequency (cf), time (t) and minutes (min) – or a suitable title.
		2	
3(b)	Median = 33	B1 FT	Must be identified. Evidence of use of graph must be seen. Strict FT $\pm \frac{1}{2}$ square on time axis.
	[IQR =] 42 – 26	M1	$41 \leq UQ \leq 43 - 25 < LQ \leq 27$. If outside of range FT $\pm \frac{1}{2}$ square on time axis.
	16	A1 FT	
		3	

PUBLISHED

Question	Answer							Marks	Guidance														
3(c)	<table><tr><td>Midpoint</td><td>7.5</td><td>20</td><td>27.5</td><td>35</td><td>45</td><td>60</td></tr><tr><td>Frequency</td><td>18</td><td>28</td><td>42</td><td>52</td><td>36</td><td>24</td></tr></table>							Midpoint	7.5	20	27.5	35	45	60	Frequency	18	28	42	52	36	24	B1	At least 5 correct midpoints or 5 correct frequencies seen.
	Midpoint	7.5	20	27.5	35	45	60																
	Frequency	18	28	42	52	36	24																
	Mean = $\frac{18 \times 7.5 + 28 \times 20 + 42 \times 27.5 + 52 \times 35 + 36 \times 45 + 24 \times 60}{200}$							M1	Correct mean formula using <i>their</i> 6 midpoints (must be within class, not upper bound, not lower bound) condone 1 error and <i>their</i> 6 frequencies (not cumulative frequencies).														
$= 33.65, 33\frac{13}{20}$							A1	Accept 33.7, not $\frac{673}{20}$.															
								3															

Question	Answer	Marks	Guidance
4(a)	$P(HRR) = \frac{1}{4} \times \frac{4}{6} \times \frac{4}{6} = \frac{16}{144}, \frac{4}{36}$ $P(TRR) = \frac{3}{4} \times \frac{3}{7} \times \frac{2}{6} = \frac{18}{168}, \frac{3}{28}$ $P(HBB) = \frac{1}{4} \times \frac{2}{6} \times \frac{2}{6} = \frac{4}{144}, \frac{1}{36}$ $P(TBB) = \frac{3}{4} \times \frac{4}{7} \times \frac{3}{6} = \frac{36}{168}, \frac{6}{28}, \frac{3}{14}$	B1	2 clearly identified unsimplified probabilities from P(HRR), P(TRR), P(HBB) and P(TBB) correct.
	$\frac{4}{36} + \frac{3}{28} + \frac{1}{36} + \frac{6}{28}$	M1	Sum of 4 correct scenarios, may be identified by the unsimplified probability calculations.
	= $\frac{29}{63}$ or 0.460	A1	(0.460317... to at least 3SF).
		3	

PUBLISHED

Question	Answer	Marks	Guidance
4(b)	$\left[P(T BB) = \frac{P(T \cap BB)}{P(BB)} \right] = \left[\frac{\frac{3}{4} \times \frac{4}{7} \times \frac{3}{6}}{\frac{1}{36} + \frac{6}{28}} \right]$ $\frac{3}{14} \div \frac{61}{252} \text{ or } \frac{\frac{3}{14}}{\frac{61}{252}}$	M1	$\frac{3}{4} \times \frac{4}{7} \times \frac{3}{6}, \frac{36}{168}$ oe, $\frac{3}{14}, 0.2142857 \dots$ seen as numerator of a fraction, accept unsimplified, FT <i>their</i> P(TBB) from 4(a)
		M1	<i>their</i> $\frac{1}{36} + \text{their } \frac{6}{28}$ FT from 4(a) or correct, 0.24206..., seen as denominator of a fraction, accept unsimplified.
	$\frac{54}{61}$ or 0.885	A1	Accept 0.8852589... rounded to at least 3SF. If one or both Ms not awarded, SC B1 for correct final answer WWW.
		3	

Question	Answer	Marks	Guidance
5(a)	$P(83 < X < 95) = P\left(\frac{83-90}{8} < Z < \frac{95-90}{8}\right)$	M1	Using $\pm$ standardisation formula with 90, 8 and <i>either</i> 83 or 95. Not σ^2 , not σ , no continuity correction.
	$= P(-0.875 < Z < 0.625)$	A1	Both ± 0.875 OE and ± 0.625 OE seen. If M0 scored, SC B1 for both ± 0.875 and ± 0.625 seen
	$[\Phi(0.625) + \Phi(0.875) - 1]$ $= 0.7340 + 0.8092 - 1$	M1	Calculating the appropriate probability area, leading to their final probability. Expect final answer > 0.5 .
	$= 0.543$	A1	0.5432, $0.543 \leq p < 0.5435$. Only dependent on the 2 nd M mark.
		4	

PUBLISHED

Question	Answer	Marks	Guidance
5(b)	[Mean = $160 \times 0.6 =$]96 [Var = $160 \times 0.6 \times 0.4 =$]38.4	B1	96 and 38.4 seen, allow unsimplified. May be seen in the standardisation formula. $\left(\frac{8\sqrt{15}}{5}, 6.19677 \dots \text{to at least 4 SF} \right)$ (implies correct variance) Withhold mark if variance clearly identified as standard deviation, condone $N(96, \sqrt{38.4})$ if standardisation formula correct or variance/standard deviation correctly stated as well.
	$P(X < 105) = P\left(Z < \frac{104.5 - 96}{\sqrt{38.4}}\right)$ $[P(Z < 1.372) = \Phi(1.372)]$	M1	Substituting <i>their</i> 96 and <i>their</i> 38.4 into the $\pm$ standardising formula (any number for 104.5), condone σ^2 or $\sqrt{\sigma}$.
		M1	Use continuity correction 104.5 or 105.5 in <i>their</i> standardisation formula. Note: $\frac{\pm 8.5}{\sqrt{38.4}}$ or $\frac{\pm 8.5}{6.197}$ seen gains M2 BOD.
	= 0.915[0]	A1	$0.9149 \leq p \leq 0.915$. If one or more M marks not scored, SC B1 for $0.9149 \leq p \leq 0.915$.

PUBLISHED

Question	Answer	Marks	Guidance
6(a)	$\frac{182.7 - \mu}{\sigma} = 1.282$	B1	1.282 or – 1.282 seen, CAO (critical value).
	$\frac{162.5 - \mu}{\sigma} = -0.253$	B1	$-0.2535 < z \leq -0.253$ or $0.253 \leq z < 0.2535$ seen.
		M1	One standardisation formula, not σ^2 , or $\sqrt{\sigma}$, with 182.7 or 162.5 substituted correctly equated to a z value (not 0.9, 0.1, 0.8159, 0.5398, 0.4, 0.6, 0.6554, 0.7257, ...).
	Solve, obtaining values for μ and σ	M1	Either a single expression with one variable eliminated formed or two expressions with both variables on the same side seen with at least one variable value stated.
	$\mu = 165.8, \sigma = 13.2$	A1	Answers must be to at least 1 DP (context).
		5	

PUBLISHED

Question	Answer	Marks	Guidance
6(b)	Method 1		
	$[P(X < 8) = 1 - P(8, 9, 10) =] 1 - ({}^{10}C_8 (0.6)^8 (0.4)^2 + {}^{10}C_9 (0.6)^9 (0.4)^1 + (0.6)^{10})$	M1	One term ${}^{10}C_x (p)^x (1-p)^{10-x}$. With $0 < p < 1, x \neq 0$ or 10 .
	$[= 1 - (0.12093 + 0.040311 + 0.0060466)]$	A1	Correct unsimplified expression. Allow 10 for ${}^{10}C_9$. Condone omission of last bracket only. If both brackets omitted in unsimplified expression allow recovery for final stated calculation of $1 - 0.1673$ or final answer WRT 0.8327.
	$= 0.833$	B1	$0.8327 < p \leq 0.833$.
	Method 2		
	$(0.4)^{10} + {}^{10}C_1 (0.6)^1 (0.4)^9 + {}^{10}C_2 (0.6)^2 (0.4)^8 + {}^{10}C_3 (0.6)^3 (0.4)^7 + {}^{10}C_4 (0.6)^4 (0.4)^6 + {}^{10}C_5 (0.6)^5 (0.4)^5 + {}^{10}C_6 (0.6)^6 (0.4)^4 + {}^{10}C_7 (0.6)^7 (0.4)^3$	M1	One term ${}^{10}C_x (p)^x (1-p)^{10-x}$. With $0 < p < 1, x \neq 0$ or 10 .
	$[1.0486 \times 10^{-4} + 1.5729 \times 10^{-3} + \dots + 0.21499]$	A1	Correct unsimplified expression.
	$= 0.833$	B1	$0.8327 < p \leq 0.833$.
		3	

PUBLISHED

Question	Answer	Marks	Guidance
7(a)	$\frac{8!}{2!2!}$	M1	$\frac{k!}{2!m!}$ $k = 7$ or 8 , $m = 1, 2$.
	= 10080	A1	
7(b)	Method 1 Number of ways with no restriction on Es – ways with Es together		
	$\frac{7!}{2!2!} - \frac{6!}{2!}$	M1	$\frac{7!}{2!2!} - r$, r integer > 1 .
	[= 1260 – 360]	M1	$s - \frac{6!}{2!}$, s integer > 360 .
	= 900	A1	
	Method 2 T ^ ^ ^ ^ ^ T with Es inserted in gaps		
	$\frac{5!}{2!} \times \frac{6 \times 5}{2}$ or $\frac{5!}{2!} \times {}^6C_2$	M1	$t \times \frac{6 \times 5}{2}$ or $t \times {}^6C_2$, t an integer > 1 .
	[= 60 × 15]	M1	$\frac{5!}{2!} \times u$, u an integer > 1 .
	=900	A1	
		3	

PUBLISHED

Question	Answer	Marks	Guidance
7(c)	Method 1 – addition		
	$T E _ _ = {}^2C_1 \times {}^2C_1 \times {}^5C_2 = 40$	B1	Either identified or correct unsimplified expression, either alone or in an addition.
	$T E E _ = {}^2C_1 \times {}^2C_2 \times {}^5C_1 = 10$	B1	Either identified or correct unsimplified expression, either alone or in an addition.
	Probability $\frac{(40+10)}{{}^9C_4}$	M1	$\frac{a}{{}^9C_4}$, a an integer < 126 . Denominator value must be seen as ${}^9C_4$ somewhere.
	$\left[\text{Percentage} = \frac{50}{126} \times 100 \right] = 39.7\%$	A1	$39.68 \leq \text{percentage} \leq 39.7$.
	Method 2 – subtraction (total arrangements with 1 T – number of arrangements with 1T 0 E)		
	$T \wedge \wedge \wedge = {}^2C_1 \times {}^7C_3 = 70$	B1	Either identified or correct unsimplified expression, either alone or in a subtraction.
	$T * * * = {}^2C_1 \times {}^5C_3 = 20$	B1	Either identified or correct unsimplified expression, either alone or in a subtraction.
	Probability $\frac{(70-20)}{{}^9C_4}$	M1	$\frac{a}{{}^9C_4}$, a an integer < 126 . Denominator value must be seen as ${}^9C_4$ somewhere.
	$\left[\text{Percentage} = \frac{50}{126} \times 100 \right] = 39.7\%$	A1	$39.68 \leq \text{percentage} \leq 39.7$.
		4	

Cambridge International AS & A Level

MATHEMATICS**9709/52**

Paper 5 Probability & Statistics 1

October/November 2024**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 October/November 2024 series for most Cambridge IGCSE, Cambridge International A and AS Level components, and some Cambridge O Level components.

This document consists of **18** printed pages.

PUBLISHED**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.

PUBLISHED**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.

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

PUBLISHED

Question	Answer	Marks	Guidance
1(a)	$[P(X N) =] \frac{12}{40}$	B1	0.3, $\frac{3}{10}$, 30% OE.
		1	
1(b)	$[P(N X) =] \frac{12}{50}$	B1	0.24, $\frac{6}{25}$ OE.
		1	
1(c)	$P(N \cap X) = \frac{12}{120}, P(N) = \frac{40}{120}, P(X) = \frac{50}{120}$ $\frac{40}{120} \times \frac{50}{120} = \frac{5}{36}, 0.138[8\dots] \neq \frac{12}{120}, 0.1$ Not independent	B1	$P(N), P(X)$ and $P(N \cap X)$ or $P(N \text{ and } X)$ notation seen and equated to the values for $P(N), P(X)$ and $P(N \cap X)$ or $P(N \text{ and } X)$. Calculation stated and evaluated. Not independent clearly stated. $\frac{5}{36} \neq \frac{12}{120}$ does not need to be stated. All values OE. Condone consistent use of A, B etc. If values for $P(N), P(X)$ stated, accept $P(N) \times P(X) = \frac{5}{36}$.
		1	

PUBLISHED

Question	Answer	Marks	Guidance
1(d)	Method 1		
	$[P(0, 1, 2) =] (0.85)^8 + {}^8C_1(0.85)^7(0.15) + {}^8C_2(0.85)^6(0.15)^2$ [= 0.27249 + 0.38469 + 0.23760]	M1	One term of form ${}^8C_x (p)^x (1-p)^{8-x}$. With $0 < p < 1$, $x \neq 0$ or 8.
		A1	Correct unsimplified expression, no terms omitted leading to final answer.
	= 0.895	B1	$0.8945 \leq p \leq 0.895$.
	Method 2		
	$[P(0, 1, 2) =] 1 - \{ {}^8C_3(0.85)^5(0.15)^3 + {}^8C_4(0.85)^4(0.15)^4 + {}^8C_5(0.85)^3(0.15)^5 + {}^8C_6(0.85)^2(0.15)^6 + {}^8C_7(0.85)(0.15)^7 + (0.15)^8 \}$	M1	One term of form ${}^8C_x (p)^x (1-p)^{8-x}$ With $0 < p < 1$, $x \neq 0$ or 8.
		A1	Correct unsimplified expression. Condone omission of final bracket '}'. If other brackets omitted, allow recovery if $1 - 0.1052[\dots]$ seen.
	= 0.895	B1	$0.8945 \leq p \leq 0.895$.
		3	

Question	Answer	Marks	Guidance
2(a)	$\left[\frac{9!}{2!} = \right] 181440$	B1	Exact value must be seen. CAO.
		1	

PUBLISHED

Question	Answer	Marks	Guidance													
2(b)	Method 1															
	<table><tr><td>Scenario number of letters between As</td><td></td><td></td></tr><tr><td>A A [^ ^ ^ ^ ^ ^ ^]</td><td>$7! \times 8$ or $8!$</td><td>[= 40320]</td></tr><tr><td>A ^ A [^ ^ ^ ^ ^ ^]</td><td>$7! \times 7$</td><td>[= 35280]</td></tr><tr><td>A ^ ^ A [^ ^ ^ ^ ^]</td><td>$7! \times 6$</td><td>[= 30240]</td></tr></table>		Scenario number of letters between As			A A [^ ^ ^ ^ ^ ^ ^]	$7! \times 8$ or $8!$	[= 40320]	A ^ A [^ ^ ^ ^ ^ ^]	$7! \times 7$	[= 35280]	A ^ ^ A [^ ^ ^ ^ ^]	$7! \times 6$	[= 30240]	B1	Correct outcome/value for 1 identified scenario, accept unsimplified.
	Scenario number of letters between As															
	A A [^ ^ ^ ^ ^ ^ ^]	$7! \times 8$ or $8!$	[= 40320]													
	A ^ A [^ ^ ^ ^ ^ ^]	$7! \times 7$	[= 35280]													
	A ^ ^ A [^ ^ ^ ^ ^]	$7! \times 6$	[= 30240]													
			M1	Add values of 3 correct scenarios, no incorrect/repeated scenarios.												
	Total: $7! \times (8 + 7 + 6)$															
= 105 840		A1	If M1 not awarded, SC B1 for 105840 WWW.													
Method 2																
<table><tr><td>Scenario number of letters between As</td><td></td><td></td></tr><tr><td>A A [^ ^ ^ ^ ^ ^ ^]</td><td>$8!$</td><td>[= 40320]</td></tr><tr><td>A ^ A [^ ^ ^ ^ ^ ^]</td><td>${}^7P_1 \times 7!$ or ${}^7C_1 \times 7!$</td><td>[= 35280]</td></tr><tr><td>A ^ ^ A [^ ^ ^ ^ ^]</td><td>${}^7P_2 \times 6!$ or ${}^7C_2 \times 2 \times 6!$</td><td>[= 30240]</td></tr></table>		Scenario number of letters between As			A A [^ ^ ^ ^ ^ ^ ^]	$8!$	[= 40320]	A ^ A [^ ^ ^ ^ ^ ^]	${}^7P_1 \times 7!$ or ${}^7C_1 \times 7!$	[= 35280]	A ^ ^ A [^ ^ ^ ^ ^]	${}^7P_2 \times 6!$ or ${}^7C_2 \times 2 \times 6!$	[= 30240]	B1	Correct outcome/value for 1 identified scenario, accept unsimplified.	
Scenario number of letters between As																
A A [^ ^ ^ ^ ^ ^ ^]	$8!$	[= 40320]														
A ^ A [^ ^ ^ ^ ^ ^]	${}^7P_1 \times 7!$ or ${}^7C_1 \times 7!$	[= 35280]														
A ^ ^ A [^ ^ ^ ^ ^]	${}^7P_2 \times 6!$ or ${}^7C_2 \times 2 \times 6!$	[= 30240]														
		M1	Add values of 3 correct scenarios, no incorrect/repeated scenarios.													
Total: $8! + {}^7P_1 \times 7! + {}^7P_2 \times 6!$ or $8! + {}^7C_1 \times 7! + {}^7C_2 \times 2 \times 6!$																
=105 840		A1	If M1 not awarded, SC B1 for 105840 WWW.													

Question	Answer	Marks	Guidance			
2(b)	Method 3					
	<table><tr><td>Scenario number of letters between As</td><td></td><td></td></tr></table>	Scenario number of letters between As			B1	Correct outcome/value for 1 identified scenario, accept unsimplified.
	Scenario number of letters between As					
	<table><tr><td>A ^ ^ ^ A [^ ^ ^ ^]</td><td>7! × 5</td><td>[= 25200]</td></tr></table>	A ^ ^ ^ A [^ ^ ^ ^]	7! × 5	[= 25200]	M1	their 2(a), or correct, subtract values of 5 correct scenarios, no incorrect/repeated scenarios.
	A ^ ^ ^ A [^ ^ ^ ^]	7! × 5	[= 25200]			
	<table><tr><td>A ^ ^ ^ ^ A [^ ^ ^]</td><td>7! × 4</td><td>[= 20160]</td></tr></table>	A ^ ^ ^ ^ A [^ ^ ^]	7! × 4	[= 20160]		
	A ^ ^ ^ ^ A [^ ^ ^]	7! × 4	[= 20160]			
	<table><tr><td>A ^ ^ ^ ^ ^ A [^ ^]</td><td>7! × 3</td><td>[= 15120]</td></tr></table>	A ^ ^ ^ ^ ^ A [^ ^]	7! × 3	[= 15120]		
	A ^ ^ ^ ^ ^ A [^ ^]	7! × 3	[= 15120]			
	<table><tr><td>A ^ ^ ^ ^ ^ ^ A [^]</td><td>7! × 2</td><td>[= 10080]</td></tr></table>	A ^ ^ ^ ^ ^ ^ A [^]	7! × 2	[= 10080]		
A ^ ^ ^ ^ ^ ^ A [^]	7! × 2	[= 10080]				
<table><tr><td>A ^ ^ ^ ^ ^ ^ ^ A</td><td>7! [× 1]</td><td>[= 5040]</td></tr></table>	A ^ ^ ^ ^ ^ ^ ^ A	7! [× 1]	[= 5040]			
A ^ ^ ^ ^ ^ ^ ^ A	7! [× 1]	[= 5040]				
Total = $\frac{9!}{2!} - 7! \times (5 + 4 + 3 + 2 + 1)$						
=105 840		A1	If M1 not awarded, SC B1 for 105840 WWW.			
		3				

PUBLISHED

Question	Answer								Marks	Guidance																
3(a)	<table><tr><td>x</td><td>0</td><td>2</td><td>4</td><td>6</td><td>8</td><td>10</td><td>12</td></tr><tr><td>$P(X = x)$</td><td>$\frac{3}{12}$, $\frac{1}{4}$ 0.25</td><td>$\frac{2}{12}$, $\frac{1}{6}$ 0.167</td><td>$\frac{2}{12}$</td><td>$\frac{2}{12}$</td><td>$\frac{1}{12}$ 0.0833</td><td>$\frac{1}{12}$</td><td>$\frac{1}{12}$</td></tr></table>								x	0	2	4	6	8	10	12	$P(X = x)$	$\frac{3}{12}$, $\frac{1}{4}$ 0.25	$\frac{2}{12}$, $\frac{1}{6}$ 0.167	$\frac{2}{12}$	$\frac{2}{12}$	$\frac{1}{12}$ 0.0833	$\frac{1}{12}$	$\frac{1}{12}$	B1	Table with correct x values and at least 2 correct probabilities. Condone any additional x values if probability stated as 0.
	x	0	2	4	6	8	10	12																		
	$P(X = x)$	$\frac{3}{12}$, $\frac{1}{4}$ 0.25	$\frac{2}{12}$, $\frac{1}{6}$ 0.167	$\frac{2}{12}$	$\frac{2}{12}$	$\frac{1}{12}$ 0.0833	$\frac{1}{12}$	$\frac{1}{12}$																		
B1									Four more probabilities correctly linked to the correct x value, need not be in table, accept unsimplified.																	
								B1	7 correct probabilities linked with correct outcomes, may not be in table. Decimals correct to at least 3 SF. SC B1 7 or more probabilities summing to 1 placed in a probability distribution table.																	
								3																		

PUBLISHED

Question	Answer	Marks	Guidance
3(b)	$[E(X) =] \left[0 \right] + 2 \times \frac{2}{12} + 4 \times \frac{2}{12} + 6 \times \frac{2}{12} + 8 \times \frac{1}{12} + 10 \times \frac{1}{12} + 12 \times \frac{1}{12}$ $\left[\left[0 \right] + \frac{4}{12} + \frac{8}{12} + \frac{12}{12} + \frac{8}{12} + \frac{10}{12} + \frac{12}{12} = \frac{54}{12} = 4.5 \right]$	M1	Accept unsimplified expression. May be calculated in variance. Accept $\frac{1}{3} + \frac{2}{3} + 1 + \frac{2}{3} + \frac{5}{6} + 1$ OE for the M mark FT <i>their</i> table with 7 or 8 probabilities summing to $0.999 \leq total \leq 1$ ($0 < p < 1$). FT acceptable at the bold partially evaluated stage.
	$[Var(X) =]$ $\left[0 \right] + 2^2 \times \frac{2}{12} + 4^2 \times \frac{2}{12} + 6^2 \times \frac{2}{12} + 8^2 \times \frac{1}{12} + 10^2 \times \frac{1}{12} + 12^2 \times \frac{1}{12} - (their\ 4.5)^2$ $\left[\frac{\left[0 \right] + 2 \times 4 + 2 \times 16 + 2 \times 36 + [1 \times] 64 + [1 \times] 100 + [1 \times] 144}{12} - \frac{81}{4} \right]$ $[= 35 - 4.5^2]$	M1	Appropriate variance formula using <i>their</i> $(E(X))^2$ value. FT <i>their</i> table with 6 or more probabilities. ($0 < p < 1$) which need not sum to 1 or with an expression no more evaluated than shown. FT acceptable at the bold partially evaluated stage with <i>their</i> probabilities.
	$= 14.75, 14\frac{3}{4}$	A1	CAO Accept $\frac{59}{4}$. If either or both M marks not awarded, SC B1 for correct answer WWW
		3	

PUBLISHED

Question	Answer	Marks	Guidance
4(a)	$P(X < 18.2) = P\left(Z < \frac{18.2 - 19.8}{2.4}\right)$	M1	Use of $\pm$ standardisation formula with 18.2, 19.8 and 2.4 substituted appropriately, no continuity correction. Condone $\sigma^2(2.4^2)$ or $\sqrt{\sigma}(\sqrt{2.4})$.
	$= [\Phi(-0.6667) = 1 - \Phi(0.6667)]$ $= 1 - 0.7477$	M1	Calculating the appropriate probability areas (leading to their final answer, expect < 0.5). Note: 0.432 is z-value of 0.667 so is not an appropriate probability area (M0).
	$= 0.252(3)$	A1	AWRT 0.252 SOI, accept 0.2525. If one or both M marks not awarded, SC B1 for AWRT 0.252 SOI, accept 0.2525.
	[Expected number = $0.2523 \times 450 = 113.5$,] $= 113$ or 114	B1FT	Strict FT <i>their</i> at least 4 figure probability $\times 450$. (Check with calculator). One integer answer only. No indication of ‘approximation’, e.g. $\approx, \cong, about$.
		4	
4(b)	$P(X > 25.5) = 0.26$ so $P\left(Z > \frac{25.5 - 23.4}{\sigma}\right) = 0.26$	B1	$0.643 \leq z \leq 0.6435$ or $-0.6435 \leq z \leq -0.643$ seen.
	$\frac{25.5 - 23.4}{\sigma} = 0.643$	M1	$\pm$ standardisation formula with 25.5, 23.4, σ equating to a z-value, (not $1 - \text{their z-value} \dots$). Condone continuity correction ± 0.05 , not σ^2 , not $\sqrt{\sigma}$.
	$\sigma = 3.27$	A1	$3.26 \leq \sigma \leq 3.27$. Do not award for improper fractions.
		3	

PUBLISHED

Question	Answer				Marks	Guidance
5(a)	${}^{10}C_4 \times {}^6C_2 \times {}^5C_1$				M1	${}^{10}C_a \times {}^6C_b \times {}^5C_c$, $a + b + c = 7$, a, b, c integers. No other terms present but condone $\times 6$ or $\times 3!$.
	$[= 210 \times 15 \times 5] = 15750$				A1	
					2	
5(b)	Scenario	V G P			M1	One product using 2 or 3 combinations with upper numbers correct and lower numbers summing to 5 and linked to a correct identified scenario. Condone the consistent use of permutations.
	VVVVG	4 1 0	${}^{10}C_4 \times {}^6C_1 [\times {}^5C_0]$	[1260]		
	VVVGG	3 2 0	${}^{10}C_3 \times {}^6C_2 [\times {}^5C_0]$	[1800]	B1	2 identified outcomes evaluated accurately, accept unsimplified.
	VVGGG	2 3 0	${}^{10}C_2 \times {}^6C_3 [\times {}^5C_0]$	[900]	M1	Add values of 5 correct scenarios, no incorrect/repeated scenarios.
	VVVGP	3 1 1	${}^{10}C_3 \times {}^6C_1 \times {}^5C_1$	[3600]		
	VVGGP	2 2 1	${}^{10}C_2 \times {}^6C_2 \times {}^5C_1$	[3375]		
	Total = 10935				A1	If either or both Ms not awarded, SC B1 for 10935 WWW
					4	

PUBLISHED

Question	Answer	Marks	Guidance																		
6(a)	<table><tr><td>Falcons</td><td></td><td>Kites</td></tr><tr><td>9 8</td><td>3</td><td>2</td></tr><tr><td>8 6 4 2</td><td>4</td><td>0 0 5 7 8</td></tr><tr><td>9 8 6 2 1 0</td><td>5</td><td>2 4 8 9 9</td></tr><tr><td>9 4</td><td>6</td><td>0 1 3 5</td></tr><tr><td>6</td><td>7</td><td></td></tr></table>	Falcons		Kites	9 8	3	2	8 6 4 2	4	0 0 5 7 8	9 8 6 2 1 0	5	2 4 8 9 9	9 4	6	0 1 3 5	6	7		B1	Correct stem, ignore extra values (not in reverse, not split). If a split stem-and-leaf plot is used (i.e. stem values are repeated) the remaining B marks are available.
	Falcons		Kites																		
	9 8	3	2																		
	8 6 4 2	4	0 0 5 7 8																		
	9 8 6 2 1 0	5	2 4 8 9 9																		
9 4	6	0 1 3 5																			
6	7																				
		B1	Correct Falcons labelled on left, leaves in order from right to left and lined up vertically, no commas or other punctuation.																		
		B1	Correct Kites labelled on same diagram, leaves in order and lined up vertically, no commas or other punctuation. Penalise each error only once in question. E.g. commas in both sets of data.																		
	Key: 1 5 4 means 51 minutes for Falcons and 54 minutes for Kites	B1	Correct key, for their diagram, need both teams names and ‘mins’ at least once here, or in leaf headings or title. <u>If 2 separate diagrams drawn</u> max marks B1 if both stems correct. B1 if Falcons correct to the left of the stem. B1 if both keys correct including ‘mins’ and team name.																		
		4																			
6(b)	Median = 51 [minutes]	B1	Accept Q2 , must be identified.																		
	[IQR =] 59 – 44	M1	$58 \leq UQ \leq 64 - 42 \leq LQ \leq 46$. Implied if both quartile values are stated and an appropriate IQR calculated accurately.																		
	= 15 [minutes]	A1	WWW																		
		3																			

PUBLISHED

Question	Answer	Marks	Guidance
6(c)	$\left[\text{mean} = \frac{792 + 783}{30} = \frac{1575}{30} = \right] 52.5, 52\frac{1}{2}, \frac{105}{2}$	B1	$\frac{1575}{30}$ is not acceptable for this mark.
	$\sum x^2 = 85727$ $\text{sd}^2 = [\text{Variance} =] \left[\frac{(43504 + 42223)}{30} - \left(\frac{792 + 783}{30} \right)^2 \right]$ $\frac{85727}{30} - \left(\frac{1575}{30} \right)^2 [= 101.3167]$	M1	Accept unsimplified variance formula. FT <i>their</i> mean. Ignore any square root leading to sd for this mark.
	$\sigma = (\sqrt{101.3167}) = 10.1$	A1	AWRT. Must be identified, e.g. sd, s, std d, σ . Condone ‘short’ square root signs. If M1 not awarded, SC B1 for, $\sigma = \sqrt{101.3167}$ or $\sqrt{\frac{6079}{60}}$ oe = 10.1.
		3	

Question	Answer	Marks	Guidance
7(a)	$[(0.6)^4 \times 0.4 =] 0.0518[4], \frac{162}{3125}$	B1	
		1	

PUBLISHED

Question	Answer	Marks	Guidance
7(b)	Method 1		
	$[P(X \leq 7) - P(X \leq 2) =] (1 - 0.6^7) - (1 - 0.6^2)$	M1	$(1 - p^7) - (1 - p^2)$ or $p^2 - p^7$ seen, $0 < p < 1$.
	$[= 0.36 - 0.02799]$ $= 0.332[0 \dots], \frac{25938}{78125}$	A1	If M0 awarded SC B1 0.3320064 or $\frac{25938}{78125}$ CAO.
	Method 2		
	$[P(X = 3, 4, 5, 6, 7) =]$ $0.4 \times 0.6^2 + 0.4 \times 0.6^3 + 0.4 \times 0.6^4 + 0.4 \times 0.6^5 + 0.4 \times 0.6^6$	M1	$(1 - p) \times p^2 + (1 - p) \times p^3 + (1 - p) \times p^4 + (1 - p) \times p^5 + (1 - p) \times p^6$ seen, $0 < p < 1$.
	$[= 0.144 + 0.0864 + 0.05184 + 0.031104 + 0.0186624]$ $= 0.332[0 \dots], \frac{25938}{78125}$	A1	If M0 awarded SC B1 0.3320064 or $\frac{25938}{78125}$ CAO.
	Method 3 – geometric series		
	$[P(X = 3, 4, 5, 6, 7) =] \frac{0.144(1 - 0.6^5)}{1 - 0.6 \text{ or } 0.4}$	M1	$\frac{0.144(1 - p^5)}{1 - p}$ seen $0 < p < 1$.
	$= 0.332[0 \dots], \frac{25938}{78125}$	A1	If M0 awarded SC B1 0.3320064 or $\frac{25938}{78125}$ CAO.
		2	

PUBLISHED

Question	Answer	Marks	Guidance
7(c)	Method 1		
	2nd goal scored on:		
	2nd attempt	$(0.4)^2$	[= 0.16]
	3rd attempt	$(0.4)^2 (0.6) \times (2 \text{ or } {}^2C_1)$	[= 0.192]
	4th attempt	$(0.4)^2 (0.6)^2 \times (3 \text{ or } {}^3C_1)$	[= 0.1728]
	5th attempt	$(0.4)^2 (0.6)^3 \times (4 \text{ or } {}^4C_1)$	[= 0.13824]
	$= 0.663, \frac{2072}{3125}$	A1	If either or both M marks not awarded, SC B1 for 0.663, $\frac{2072}{3125}$ WWW condone 1 index error.
	Method 2		
	${}^5C_2(0.4)^2(0.6)^3 + {}^5C_3(0.4)^3(0.6)^2 + {}^5C_4(0.4)^4(0.6)^1 + {}^5C_5(0.4)^5$ [0.3456 + 0.2304 + 0.0768 + 0.01024] or $1 - ({}^5C_0 (0.6)^5 + {}^5C_1(0.4)^1(0.6)^4)$	M1	At least 2 correct unsimplified terms.
		M1	Add values for 4 terms of the form ${}^5C_a(0.4)^a(0.6)^{5-a}$ or $1 - \text{sum of 2 terms of the form } {}^5C_a(0.4)^a(0.6)^{5-a}.$
	$= 0.663, \frac{2072}{3125}$	A1	If either or both M marks not awarded, SC B1 for 0.663 www condone 1 index error.
		3	

PUBLISHED

Question	Answer	Marks	Guidance
7(d)	[Mean = $75 \times 0.4 =$] 30 [Variance = $75 \times 0.4 \times 0.6 =$] 18	B1	30 and 18 seen, allow unsimplified. May be seen in standardisation formula. ($\sigma = \sqrt{18}, 3\sqrt{2}, 4.2426 \leq \sigma \leq 4.243$ implies correct variance) Withhold mark if variance clearly identified as standard deviation.
	$P(28 < X < 35) = P\left(\frac{28.5 - 30}{\sqrt{18}} < Z < \frac{34.5 - 30}{\sqrt{18}}\right)$	M1	Substituting <i>their</i> μ and positive σ into one $\pm$ standardising formula (any number for 28.5 or 34.5), not σ^2 , not $\sqrt{\sigma}$.
		M1	Using continuity corrections 27.5 <i>or</i> 28.5 and 34.5 <i>or</i> 35.5 in <i>their</i> 2 separate standardisation formula.
	$[= \Phi(1.0607) + \Phi(0.3536) - 1]$ = 0.8556 + 0.6383 – 1 Or 0.8556 – (1 – 0.6383) Or 0.8556 – 0.3617 Or (0.8556 – 0.5) + (0.6383 – 0.5) Or 0.3556 + 0.1383	M1	Appropriate area Φ , from final process. Must be a probability.
	= 0.494	A1	AWRT.
		5	

Cambridge International AS & A Level

MATHEMATICS**9709/53**

Paper 5 Probability & Statistics 1

October/November 2024**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 October/November 2024 series for most Cambridge IGCSE, Cambridge International A and AS Level components, and some Cambridge O Level components.

This document consists of **18** printed pages.

PUBLISHED**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.

PUBLISHED**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.

PUBLISHED**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.

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

PUBLISHED

Question	Answer	Marks	Guidance
1(a)	$0.3^3 + 0.7^3$ or $1 - (3 \times 0.3^2 \times 0.7 + 3 \times 0.3 \times 0.7^2) = [1 - 0.63]$	M1	$p^3 + q^3, p + q = 1, p, q > 0$ or $1 - (3 \times p^2 \times q + 3 \times p \times q^2),$ $p + q = 1, p, q > 0.$
	0.37[0]	A1	$\frac{37}{100}$.
		2	

PUBLISHED

Question	Answer	Marks	Guidance
1(b)	[Mean = $125 \times 0.3 =$] 37.5 [Variance = $125 \times 0.3 \times 0.7 =$] 26.25	B1	37.5 or $37\frac{1}{2}$ and 26.25, $26\frac{1}{4}$ seen, allow unsimplified. May be seen in standardisation formula. $([\sigma =] 5.12, \frac{\sqrt{105}}{2} \text{ implies correct variance}).$
	$P(X > 45) = P(Z > \frac{45.5 - 37.5}{\sqrt{26.25}})$	M1	Substituting their <i>mean</i> and <i>their</i> positive standard deviation into the $\pm$ standardising formula (any number for 45.5), not <i>their</i> σ^2 , not <i>their</i> $\sqrt{\sigma}$.
		M1	Use continuity corrections 44.5 or 45.5 in <i>their</i> standardisation formula Note: $\frac{\pm 8}{\sqrt{26.25}}$ or $\frac{\pm 8}{5.123}$ seen gains M2 BOD
	$[1 - \Phi(\text{their } 1.5614)] = 1 - \text{their } 0.9407$	M1	Appropriate area Φ , from final process, must be a probability. Expect final answer < 0.5. Note: appropriate final answer implies this M1.
	0.0593	A1	$0.0592 \leq p \leq 0.0593.$
		5	

PUBLISHED

Question	Answer	Marks	Guidance																								
2(a)	<table><tr><td>x</td><td>1</td><td>2</td><td>3</td><td>4</td><td>6</td></tr><tr><td>P(X = x)</td><td>$\frac{6}{36}$</td><td>$\frac{12}{36}$</td><td>$\frac{6}{36}$</td><td>$\frac{6}{36}$</td><td>$\frac{6}{36}$</td></tr><tr><td></td><td>$\frac{1}{6}$</td><td>$\frac{1}{3}$</td><td>$\frac{1}{6}$</td><td>$\frac{1}{6}$</td><td>$\frac{1}{6}$</td></tr><tr><td></td><td>0.167</td><td>0.333</td><td>0.167</td><td>0.167</td><td>0.167</td></tr></table>	x	1	2	3	4	6	P(X = x)	$\frac{6}{36}$	$\frac{12}{36}$	$\frac{6}{36}$	$\frac{6}{36}$	$\frac{6}{36}$		$\frac{1}{6}$	$\frac{1}{3}$	$\frac{1}{6}$	$\frac{1}{6}$	$\frac{1}{6}$		0.167	0.333	0.167	0.167	0.167	B1	Table with correct x values and at least one correct probability linked with the correct x-value. Values need not be in order, lines may not be drawn, may be vertical, x and P(X) may be omitted. Condone any additional x values if probability stated as 0.
		x	1	2	3	4	6																				
		P(X = x)	$\frac{6}{36}$	$\frac{12}{36}$	$\frac{6}{36}$	$\frac{6}{36}$	$\frac{6}{36}$																				
			$\frac{1}{6}$	$\frac{1}{3}$	$\frac{1}{6}$	$\frac{1}{6}$	$\frac{1}{6}$																				
		0.167	0.333	0.167	0.167	0.167																					
B1	4 correct probabilities linked with the correct x-values, need not be in table, accept unsimplified.																										
B1	5 correct probabilities linked with correct x-values, may not be in table. Decimals correct to at least 3 SF. SC B1 4 or 5 probabilities summing to 1 placed in a probability distribution table with 4 or 5 x-values between 1 and 6 inclusive.																										
3																											
2(b)	$[E(X) = \frac{1}{36}(6 + 24 + 18 + 24 + 36) =] 3$	B1 FT	FT <i>their</i> table with 4 or 5 probabilities ($0 < p < 1$) summing to 1.																								
		1																									

PUBLISHED

Question	Answer	Marks	Guidance
3(a)	$P(X > 170) = P(Z > \frac{170-176}{4.8})$	M1	Using $\pm$ standardisation formula with 170, 176 and 4.8 substituted appropriately. Condone σ^2 and $\sqrt{\sigma}$. No continuity correction.
	$[\Phi(1.25)] = 0.894$	M1	Appropriate area Φ , from final process, must be a probability. Expect final answer > 0.5 .
		A1	0.894 or $0.89435 \leq p \leq 0.8944$. If A0 scored, SC B1 for 0.894 or $0.89435 \leq p \leq 0.8944$, WWW.
		3	
3(b)	$P(h < 170) = 1 - 0.8944 = 0.1056$	M1	1 – <i>their 3(a)</i> seen or implied by 0.7056 or 0.2944
	$\frac{k-176}{4.8} [\Phi^{-1}(0.1056+0.6)] = 0.541$	B1	$0.540 < z \leq 0.541$ or $-0.541 \leq z < 0.540$ seen.
		M1	Use of $\pm$ standardisation formula with k , 176, 4.8 equated to a z-value (not 1.25, 0.7601, 0.2399, 0.7056, 0.7257, 0.8313, 0.253 ± 0.894 , 0.6, 0.4), not 4.8^2 , not $\sqrt{4.8}$, no continuity correction.
	$k = 178.6$	A1	CAO (answer required to 1 dp).
		4	

Question	Answer	Marks	Guidance																								
4(a)	<table><tr><td>H(cm)</td><td>10–19</td><td>20–29</td><td>30–39</td><td>40–44</td><td>45–49</td><td>50–54</td><td>55–59</td></tr><tr><td>UB</td><td>19.5</td><td>29.5</td><td>39.5</td><td>44.5</td><td>49.5</td><td>54.5</td><td>59.5</td></tr><tr><td>cf</td><td>[10]</td><td>28</td><td>60</td><td>102</td><td>130</td><td>144</td><td>150</td></tr></table>	H(cm)	10–19	20–29	30–39	40–44	45–49	50–54	55–59	UB	19.5	29.5	39.5	44.5	49.5	54.5	59.5	cf	[10]	28	60	102	130	144	150	B1	Cf values 28, 60, 102, 130, 144, 150 seen, Condone omission of 10. May be implied by accurate plotting (scale no less than 1cm = 10). May be by data table.
	H(cm)	10–19	20–29	30–39	40–44	45–49	50–54	55–59																			
	UB	19.5	29.5	39.5	44.5	49.5	54.5	59.5																			
	cf	[10]	28	60	102	130	144	150																			
	B1	Linearly scaled axes correctly labelled cumulative frequency (cf) (from 0 to 150) and height (h) and centimetres (cm) (from 9.5 to 59.5) with at least 3 values identified on each. Axes can be the other way round.																									
	M1	At least 4 points plotted at upper boundary ± 0.5, (e.g. allow (19, 19.5 or 20, 10) etc.) on correctly scaled axes. (9.5,0), (19.5,10), (29.5, 28), (39.5, 60), (44.5,102), (49.5, 130), (54.5, 144), (59.5,150).																									
	A1	All points plotted correctly, curve drawn (within tolerance), joined to (9.5, 0) and not going beyond above 150 vertically. A0 if straight line segments used.																									
		4																									

PUBLISHED

Question	Answer	Marks	Guidance
4(b)	$[150 \times 0.3 = 45]$	M1	Use of graph must be seen.
	Line drawn from 45 on cf axis to meet graph at $h = 36$	A1 FT	Must be an increasing cf graph. Expect an answer in range $35 \leq h \leq 37$ for a correct graph.
		2	
4(c)	Midpoints 14.5, 24.5, 34.5, 42, 47, 52, 57	B1	At least 6 correct midpoints seen, may be unsimplified, may be in calculation, may be by data table.
	$\text{Mean} = \frac{10 \times 14.5 + 18 \times 24.5 + 32 \times 34.5 + 42 \times 42 + 28 \times 47 + 14 \times 52 + 6 \times 57}{150}$ $\left[= \frac{145 + 441 + 1104 + 1764 + 1316 + 728 + 342}{150} \right]$	M1	Correct unsimplified mean formula with <i>their</i> midpoints (not ub, lb, upper limits, lower limits, cw, fd, f or cf and must be within class). If midpoints correct, accept partially evaluated.
	$= \frac{5840}{150}, \frac{584}{15}, 38\frac{14}{15}, 38.9$	A1	Accept answers wrt 38.9 WWW If M1 withheld, SC B1 for $\frac{5840}{150}, \frac{584}{15}, 38\frac{14}{15}, 38.9$.
	$\text{sd}^2 = \frac{10 \times 14.5^2 + 18 \times 24.5^2 + 32 \times 34.5^2 + 42 \times 42^2 + 28 \times 47^2 + 14 \times 52^2 + 6 \times 57^2}{150} - \left(\text{their} \frac{5840}{150} \right)^2$ $\left[= \frac{244285}{150} - \left(\text{their} \frac{5840}{150} \right)^2 \right]$	M1	Correct unsimplified variance formula with <i>their</i> midpoint (not ub, lb, upper limits, lower limits, cw, fd, f or cf and must be within class). If midpoints correct, accept partially evaluated
	$[= 112.76]$ standard deviation $\left[\sqrt{112.76} \right] = 10.6$	A1	AWRT 10.6 WWW. If second M1 withheld, SC B1 for 10.6 WWW.
		5	

PUBLISHED

Question	Answer	Marks	Guidance
5(a)	Method 1		
	$[P(0, 1, 2) =] {}^8C_2(0.75)^6(0.25)^2 + {}^8C_1(0.75)^7(0.25)^1 + (0.75)^8$	M1	One term ${}^8C_x$. $(p)^x(1-p)^{8-x}, 0 < p < 1, 0 < x < 8$.
	$[= 0.31146 + 0.26697 + 0.10011] =$	A1	Correct expression, accept unsimplified, no terms omitted leading to final answer.
	$= 0.679$	B1	AWRT.
		3	
	Method 2		
	$[P(0, 1, 2) = 1 - P(3, 4, 5, 6, 7, 8) =] 1 - \{ {}^8C_3(0.75)^5(0.25)^3 + {}^8C_4(0.75)^4(0.25)^4 + {}^8C_5(0.75)^3(0.25)^5 + {}^8C_6(0.75)^2(0.25)^6 + {}^8C_7(0.75)(0.25)^7 + (0.25)^8 \}$	M1	One term ${}^8C_x (p)^x(1-p)^{8-x}$, $0 < p < 1, 0 < x < 8$.
		A1	Correct expression, accept unsimplified, condone omission of up to 3 ‘middle’ terms, leading to final answer.
	$= 0.679$	B1	AWRT.
		3	

PUBLISHED

Question	Answer	Marks	Guidance
5(b)	Method 1		
	$1 - 0.75^6$	M1	$1 - 0.75^n, n = 6, 7$.
	$= 0.822, \frac{3367}{4096}$	A1	0.82202148... to at least 3SF.
	Method 2		
	$0.25 + 0.25 \times 0.75 + 0.25 \times 0.75^2 + 0.25 \times 0.75^3 + 0.25 \times 0.75^4 + 0.25 \times 0.75^5$	M1	Summing 6 or 7 terms – condone extra term 0.25×0.75^6 .
	$= 0.822$	A1	
	Method 3		
	$1 - 0.75^7 - 0.25 \times 0.75^6$	M1	Correct expression.
	$= 0.822$	A1	
		2	

PUBLISHED

Question	Answer	Marks	Guidance															
5(c)	Method 1 P(2nd gold $\cap$ 5th is first unwrapped). R G RorG RorG U																	
	$0.25 \times 0.3 \times 0.55 \times 0.55 \times 0.45 [= 0.01021]$ on its own or as a numerator	M1	$a \times 0.3 \times b \times c \times 0.45$ $0 < a, b, c < 1$. $a \neq 0.3, 0.45$ $b, c \neq 0.45$. multiplied in that order, or correct.															
		A1	5 correct probabilities multiplied.															
	Method 2 P(2nd gold $\cap$ 5th is first unwrapped).4 possible scenarios																	
	<table><tr><td>R G R G U</td><td>$0.25 \times 0.3 \times 0.25 \times 0.3 \times 0.45$</td><td>[= 0.00253125]</td></tr><tr><td>R G R R U</td><td>$0.25 \times 0.3 \times 0.25 \times 0.25 \times 0.45$</td><td>[= 0.002109375]</td></tr><tr><td>R G G R U</td><td>$0.25 \times 0.3 \times 0.3 \times 0.25 \times 0.45$</td><td>[= 0.00253125]</td></tr><tr><td>R G G G U</td><td>$0.25 \times 0.3 \times 0.3 \times 0.3 \times 0.45$</td><td>[= 0.0030375]</td></tr><tr><td></td><td>[Total</td><td>0.010209375]</td></tr></table>	R G R G U	$0.25 \times 0.3 \times 0.25 \times 0.3 \times 0.45$	[= 0.00253125]	R G R R U	$0.25 \times 0.3 \times 0.25 \times 0.25 \times 0.45$	[= 0.002109375]	R G G R U	$0.25 \times 0.3 \times 0.3 \times 0.25 \times 0.45$	[= 0.00253125]	R G G G U	$0.25 \times 0.3 \times 0.3 \times 0.3 \times 0.45$	[= 0.0030375]		[Total	0.010209375]	M1	$a \times 0.3 \times b \times c \times 0.45$ $0 < a, b, c < 1$. $a \neq 0.3, 0.45$ $b, c \neq 0.45$. 4 terms in this form seen added on their own or as a numerator.
		R G R G U	$0.25 \times 0.3 \times 0.25 \times 0.3 \times 0.45$	[= 0.00253125]														
		R G R R U	$0.25 \times 0.3 \times 0.25 \times 0.25 \times 0.45$	[= 0.002109375]														
		R G G R U	$0.25 \times 0.3 \times 0.3 \times 0.25 \times 0.45$	[= 0.00253125]														
		R G G G U	$0.25 \times 0.3 \times 0.3 \times 0.3 \times 0.45$	[= 0.0030375]														
			[Total	0.010209375]														
	A1	All probabilities correct and attempt to sum the 4 scenarios.																
For either approach																		
$[P(5^{\text{th}} \text{ is first unwrapped)} =] (0.55)^4 (0.45) [= 0.041178]$	B1																	
$[P(2^{\text{nd}} \text{ is first gold} \mid 5^{\text{th}} \text{ is first unwrapped)} =] \frac{0.25 \times 0.3 \times 0.55 \times 0.55 \times 0.45}{(0.55)^4 (0.45)}$ $\left[= \frac{0.010209375}{0.0411778125} \right]$	M1	$\frac{\text{their } P(2^{\text{nd}} \text{ gold} \cap 5^{\text{th}} \text{ is first unwrapped})}{\text{their } P(5^{\text{th}} \text{ is first unwrapped})}$. Their probabilities must be clearly identified if incorrect.																
$= 0.248, \frac{30}{121}$	A1	0.24793...																

PUBLISHED

Question	Answer	Marks	Guidance
5(c)	Method 3 First chocolate is red and second gold $P(\text{red given that it is wrapped}) \times P(\text{gold given that it is wrapped}) = \frac{0.25}{0.55} \times \frac{0.3}{0.55}$	M1	Either $\frac{0.25}{0.55 \text{ or } 0.45}$ or $\frac{0.3}{0.55 \text{ or } 0.45}$.
		A1	Either $\frac{0.25}{0.55}$ or $\frac{0.3}{0.55}$.
		B1	Both probs correct, can be unsimplified.
		M1	Multiplying their identified P(red given wrapped) by their identified P(gold given wrapped) or correct.
	$= 0.248, \frac{30}{121}$	A1	
		5	

Question	Answer	Marks	Guidance
6(a)	$\left[\frac{9!}{2!2!} = \right] 90720$	B1	
		1	

PUBLISHED

Question	Answer	Marks	Guidance
6(b)	Method 1 Total arrangements – arrangements with repeated letters at ends		
	$\frac{9!}{2!2!} - \frac{7!}{2!} \times 2$	M1	$a - \frac{7!}{2!} \times b$ $a = \text{their } 6(a)$ or correct, $b = 1, 2$.
		M1	$a - \frac{7!}{c!} \times 2$ $a = \text{their } 6(a)$ or correct, $c = 1, 2$.
	85680	A1 FT	ft their 6(a) – 5040.
	Method 2 Adding no of different ways		
	P and S at ends $2 \times 7! = 10080$	M1	Finding correct number of ways for one of these correctly identified scenarios.
	P or S at one end only $4 \times 5 \times \frac{7!}{2!} = 50400$	M1	Adding no of ways for 3 correctly identified scenarios.
	Neither P nor S at an end $5 \times 4 \times \frac{7!}{2!2!} = 25200$		
	Total 85680	A1	
	Method 3		
	P at beginning $7 \times \frac{7!}{2!} = 17640$	M1	Finding correct number of ways for one of these correctly identified scenarios.
	S at beginning $7 \times \frac{7!}{2!} = 17640$	M1	Adding no of ways for 3 correctly identified scenarios.
	Neither P nor S at beginning $5 \times \frac{8!}{2!2!} = 50400$		
	Total 85680	A1	
		3	

PUBLISHED

Question	Answer	Marks	Guidance
6(c)	Method 1 arrangements with PP between Ss { S P P S ^ ^ ^ ^ } add arrangements with PP not between Ss { (S ^ ^ S) ^ P P ^ }		
	$6! + 5 \times 5 \times 4$	M1	$6! + d$, d an integer ≥ 1 , may be implied.
	$6! + 5 \times 5 \times 4$	M1	$e + 5 \times f$, e, f integers ≥ 1 , may be implied.
		M1	$e + g \times (5 \times 4 \text{ or } {}^5P_2)$, e an integer ≥ 1 , $g = 4, 5, 6$.
	[Total] = 3120	A1	
	Method 2 - considers the 6 positions for S ^ ^ S		
	Positions 1 and 6 there are $5 \times 5!$ ways	M1	Identifying no of ways if S ^ ^ S is in position 1 or 6.
	Positions 2, 3, 4 and 5 there are $4 \times 5!$ ways	M1	Identifying no of ways if S ^ ^ S is in position 2, 3, 4 or 5.
	$2 \times 5 \times 5! + 4 \times 4 \times 5!$	M1	Adding no of ways for 6 scenarios (or $26 \times 5!$).
	[Total] = 3120	A1	SC B1 for 3120 if any method marks are withheld.
		4	

PUBLISHED

Question	Answer	Marks	Guidance
6(d)	Method 1 Either PP in the group of 5 or PP in the group of 4		
	$\frac{{}^5C_3 + {}^5C_2}{{}^9C_5},$ $\frac{{}^5C_3 + {}^5C_2}{{}^9C_5}$	M1	$a \times {}^5C_2$, $a \times {}^5C_3$, or ${}^5C_2 + {}^5C_3$ seen as a numerator of one or two fractions where a is 1 or 2, no extra terms.
		M1	${}^9C_5$ or ${}^9C_4$ seen (no addition, multiplication) as a denominator of one or two fractions.
	Probability = $\frac{20}{126}, \frac{10}{63}$, 0.159	A1	
	Method 2 Considering the positions of P and then S		
	$\left(\frac{5}{9} \times \frac{4}{8} \times \frac{4}{7} \times \frac{3}{6}\right) + \left(\frac{5}{7} \times \frac{4}{6} \times \frac{4}{9} \times \frac{3}{8}\right)$	M1	$a \times 5 \times 4 \times 4 \times 3$ seen as a numerator of a fraction. where $a = 1$ or 2.
	$\left(\frac{5}{9} \times \frac{4}{8} \times \frac{4}{7} \times \frac{3}{6}\right) + \left(\frac{5}{7} \times \frac{4}{6} \times \frac{4}{9} \times \frac{3}{8}\right)$ $= \frac{10}{63}$	M1	$9 \times 8 \times 7 \times 6$ seen as a denominator of a fraction.
		A1	
		3	