

Cambridge International A Level

MATHEMATICS**9709/51**

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.

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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 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.
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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.
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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.

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.
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 - 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).
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Abbreviations

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1(a)	<table><tr><td colspan="2" rowspan="7"> Blue </td><td colspan="6"> Red </td></tr><tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td></tr><tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td></tr><tr><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td></tr><tr><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr><tr><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td></tr><tr><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td>11</td></tr><tr><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td>11</td><td>12</td></tr></table>	Blue		Red						1	2	3	4	5	6	1	2	3	4	5	6	7	2	3	4	5	6	7	8	3	4	5	6	7	8	9	4	5	6	7	8	9	10	5	6	7	8	9	10	11	6	7	8	9	10	11	12	M1	Complete outcome space or or listing A and B outcomes or listing A∩B outcomes
	Blue			Red																																																							
				1	2	3	4	5	6																																																		
1				2	3	4	5	6	7																																																		
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5			6	7	8	9	10	11																																																			
6	7	8	9	10	11	12																																																					
$P(A \cap B) = \frac{5}{36}$	A1	With evidence																																																									
	2																																																										

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Question	Answer	Marks	Guidance
1(b)	$P(A) \times P(B) = \frac{1}{3} \times \frac{10}{36}$	M1	<i>Their</i> $\frac{1}{3} \times$ <i>their</i> $\frac{10}{36}$ seen
	$\frac{5}{54} \neq \frac{5}{36}$ so not independent	A1	$\frac{5}{54}, \frac{5}{36}$, $P(A) \times P(B)$ and $P(A \cap B)$ seen in workings and correct conclusion stated Condone $\frac{5}{36}$ being stated in (a)
	Alternative method for question 1(b)		
	$P(B A) = P(B)$ $P(B A) = \frac{P(A \cap B)}{P(A)} = \frac{\frac{5}{36}}{\frac{1}{3}}$	M1	OE, <i>their</i> $\frac{1(a)}{\text{their } P(A)}$ seen
	$\frac{5}{12} \neq \frac{5}{18}$ so not independent	A1	$P(A B)$, $P(B)$, $\frac{5}{12}, \frac{5}{18}$ seen in workings and correct conclusion stated Condone $\frac{5}{18} \equiv \frac{10}{36}$ being identified in (a)
		2	

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Question	Answer	Marks	Guidance
2(a)	$0.6 \times 0.7 + 0.4(1 - x) = 0.58$ $\equiv 0.42 + 0.4(1 - x) = 0.58$	M1	Equation of form $0.6 \times a + 0.4 \times b = 0.58$; $a = 0.3, 0.7, b = x, (1 - x)$
		B1	Single correct product seen, condone 0.42, in an equation of appropriate form
	$x = 0.6$	A1	
	Alternative method for question 2(a)		
	$0.6 \times 0.3 + 0.4x = 0.42$ $\equiv 0.18 + 0.4x = 0.42$	M1	Equation of form $0.6 \times a + 0.4 \times b = 0.42$; $a = 0.3, 0.7, b = x, (1 - x)$
		B1	Single correct product seen, condone 0.18, in an equation of appropriate form
	$x = 0.6$	A1	
		3	
2(b)	$(0.6 \times 0.3)^2$	M1	$(a \times b)^2$, $a = 0.6, 0.4$ and $b = 0.7, 0.3, x, (1 - x)$ or 0.18^2 , alone.
	0.0324	A1	
		2	
3(a)	$P(X > 6) = 0.75^6$	M1	p^n , $n = 6, 7$ $0 < p < 1$
	$0.178, \frac{729}{4096}$	A1	0.17797...
		2	

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Question	Answer	Marks	Guidance																																			
3(b)	$1 - P(0, 1, 2) = 1 - (0.75^{10} + {}^{10}C_1 0.25^1 0.75^9 + {}^{10}C_2 0.25^2 0.75^8)$	M1	Binomial term of form ${}^{10}C_x p^x (1-p)^{10-x}$, $0 < p < 1$, any $p, x \neq 0, 10$																																			
	$1 - (0.0563135 + 0.1877117 + 0.2815676)$	A1	Correct unsimplified expression																																			
	0.474	A1	$0.474 \leq p \leq 0.4744$																																			
		3																																				
4(a)	<table border="1"><tr><td>y</td><td>1</td><td>2</td><td>3</td><td>4</td></tr><tr><td>prob</td><td>$\frac{7}{16}$</td><td>$\frac{5}{16}$</td><td>$\frac{3}{16}$</td><td>$\frac{1}{16}$</td></tr></table>	y	1	2	3	4	prob	$\frac{7}{16}$	$\frac{5}{16}$	$\frac{3}{16}$	$\frac{1}{16}$	B1	<table border="1"><tr><td></td><td>1</td><td>2</td><td>3</td><td>4</td></tr><tr><td>1</td><td>1</td><td>1</td><td>2</td><td>3</td></tr><tr><td>2</td><td>1</td><td>2</td><td>1</td><td>2</td></tr><tr><td>3</td><td>2</td><td>1</td><td>3</td><td>1</td></tr><tr><td>4</td><td>3</td><td>2</td><td>1</td><td>4</td></tr></table> Probability distribution table with correct scores with at least one probability, allow extra score values if probability of zero stated'		1	2	3	4	1	1	1	2	3	2	1	2	1	2	3	2	1	3	1	4	3	2	1	4
	y	1	2	3	4																																	
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3	2	1	3	1																																		
4	3	2	1	4																																		
	B1	One probability (linked with correct score) correct																																				
	B1	2 more probs (linked with correct scores) correct																																				
	B1 FT	4 th prob correct, FT sum of 3 or 4 terms = 1																																				
	4																																					

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Question	Answer	Marks	Guidance
4(b)	$P(2 \text{even}) = \frac{\frac{5}{6}}{\frac{16}{6}}$	M1	$\frac{\text{their } P(2)}{\text{their } P(2) + \text{their } P(4)}$ seen or correct outcome space.
	$\frac{5}{6}$ or 0.833	A1	
		2	
5(a)	$P(X > 4.2) = P\left(z > \frac{4.2 - 3.5}{0.9}\right)$ $= P(z > 0.7778)$	M1	Using $\pm$ standardisation formula, no $\sqrt{\sigma}$ or σ^2 , continuity correction
	$1 - 0.7818$	M1	Appropriate area Φ , from standardisation formula $P(z > \dots)$ in final solution
	0.218	A1	
		3	
5(b)	$z = -1.282$	B1	± 1.282 seen (critical value)
	$\frac{t - 3.5}{0.9} = -1.282$	M1	An equation using $\pm$ standardisation formula with a z -value, condone $\sqrt{\sigma}$, σ^2 and continuity correction
	$t = 2.35$	A1	AWRT, only dependent on M mark
		3	

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Question	Answer	Marks	Guidance
5(c)	$P(2.8 < X < 4.2) = 1 - 2 \times \text{their 5(a)}$ $\equiv 2(1 - \text{their 5(a)}) - 1$ $\equiv 2(0.5 - \text{their 5(a)})$ $= 0.5636$	B1 FT	FT from <i>their 5(a)</i> < 0.5 or correct Accept unevaluated probability OE Accept 0.564
	Number of days = $365 \times 0.5636 = 205.7$	M1	$365 \times \text{their } p$
	So, 205 (days)	A1 FT	Accept 205 or 206, not 205.0 or 206.0 no approximation/ rounding stated FT must be an integer value
	Alternative method for question 5(c)		
	$P\left(\frac{2.8-3.5}{0.9} < z < \frac{4.2-3.5}{0.9}\right)$ $= \Phi(0.7778) - (1 - \Phi(0.7778))$ $= 0.7818 - (1 - 0.7818)$ $= 0.5636$	B1	$0.5635 < p \leq 0.564$ OE
	Number of days = $365 \times 0.5636 = 205.7$	M1	$365 \times \text{their } p$
	So, 205 (days)	A1 FT	Accept 205 or 206, not 205.0 or 206.0 no approximation/ rounding stated FT must be an integer value
		3	

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Question	Answer	Marks	Guidance
6(a)		M1	At least 4 points plotted at upper end points, with both scales linear with at least 3 values indicated
	Correct cumulative frequency curve	A1	All plotted correctly with curve drawn joined to (0, 0), axes labelled cumulative frequency, time, minutes
		2	
6(b)	$150 \times 0.76 = 114$	M1	114 SOI, may be on graph
	$k = 45$ (mins)	A1 FT	Clear indication that <i>their</i> graph has been used, tolerance ± 1 mm
		2	

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Question	Answer	Marks	Guidance
6(c)	Frequencies: 12 36 58 28 16	B1	Correct frequencies seen
	Mean = $\frac{10 \times 12 + 25 \times 36 + 35 \times 58 + 50 \times 28 + 80 \times 16}{150}$	B1	At least 4 correct midpoints seen and used
	$\frac{120 + 900 + 2030 + 1400 + 1280}{150}$	M1	Correct formula with <i>their</i> midpoints (not upper boundary, lower boundary, class width or frequency density).
	38.2, $38\frac{1}{5}$	A1	
	Variance = $\frac{12 \times 10^2 + 36 \times 25^2 + 58 \times 35^2 + 28 \times 50^2 + 16 \times 80^2}{150} - \text{mean}^2$ = $\frac{1200 + 22500 + 71050 + 70000 + 102400}{150} - \text{mean}^2$	M1	Substitute <i>their</i> midpoints and frequencies (condone use of cumulative frequency) in correct variance formula, must have ‘– <i>their</i> mean ² ’
	(Standard deviation = $\sqrt{321.76}$) = 17.9	A1	
		6	
7(a)	$\frac{8!}{2!}$	M1	$\frac{8!}{k} \equiv \frac{7 \times 8}{k}$, where $k \in \mathbb{N}$, $\frac{a!}{2(!)}$, where $a \in \mathbb{N}$
	20160	A1	
		2	

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Question	Answer	Marks	Guidance
7(b)	Total number of ways: $\frac{10!}{2!3!}$ (= 302 400) (A)	B1	Accept unsimplified
	With Ps together: $\frac{9!}{3!}$ (= 60 480) (B)	B1	Accept unsimplified
	With Ps not together: 302 400 – 60 480	M1	$\frac{10!}{m} - \frac{9!}{n}$, m, n integers or (A) – (B) if clearly identified
	241 920	A1	
	Alternative method for question 7(b)		
	$\frac{8!}{3!}$	B1	$k \times 8!$ in numerator, k a positive integer, no $\pm$
		B1	$m \times 3!$ in denominator, m a positive integer, no $\pm$
	$\times \frac{9 \times 8}{2}$	M1	Their $\frac{8!}{3!}$ multiplied by ${}^9C_2$ or ${}^9P_2$ no additional terms
	241 920	A1	Exact value, WWW
		4	

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Question	Answer	Marks	Guidance
7(c)	$\text{Probability} = \frac{\text{Number of ways Es at beginning and end}}{\text{Total number of ways}}$ $\text{Probability} = \frac{\frac{8!}{2!}}{\frac{10!}{2 \times 3!}} = \frac{20160}{302400}$	M1	$\left(\frac{8!}{k!}\right) \frac{1}{10!} 1 \leq k, l \in \mathbb{N} \leq 3$, FT denominator from 7(b) or correct $k!!$
	$\frac{1}{15}, 0.0667$	A1	
	Alternative method for question 7(c)		
	$\text{Probability} = \frac{3}{10} \times \frac{2}{9}$	M1	$\frac{a}{10} \times \frac{a-1}{9} a = 3, 2$
	$\frac{1}{15}, 0.0667$	A1	
	Alternative method for question 7(c)		
	$\text{Probability} = \frac{1}{10} \times \frac{1}{9} \times 3!$	M1	$\frac{1}{10} \times \frac{1}{9} \times m!, m = 3, 2$
	$\frac{1}{15}, 0.0667$	A1	
		2	

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Question	Answer	Marks	Guidance
7(d)	Scenarios: P E E E ${}^5C_0 = 1$	M1	${}^5C_x$ seen alone, $1 \leq x \leq 4$
	P E E _ ${}^5C_1 = 5$	M1	Summing the number of ways for 3 or 4 correct scenarios (can be unsimplified), no incorrect scenarios
	P E _ _ ${}^5C_2 = 10$		
	P _ _ _ ${}^5C_3 = 10$		
	Total = 26	A1	
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	$0.598, \frac{4651}{7776}$	A1	
		2	
1(b)	$(1 - P(0, 1, 2))$ $1 - \left(\left(\frac{5}{6}\right)^{10} + {}^{10}C_1 \left(\frac{1}{6}\right) \left(\frac{5}{6}\right)^9 + {}^{10}C_2 \left(\frac{1}{6}\right)^2 \left(\frac{5}{6}\right)^8\right)$	M1	${}^{10}C_x p^x (1 - p)^{10-x}, 0 < p < 1, \text{ any } p, x \neq 0, 10$
	$1 - (0.1615056 + 0.3230111 + 0.290710)$	A1	Correct expression, accept unsimplified, condone omission of final bracket
	0.225	A1	$0.2247 < p \leq 0.225, \text{ WWW}$
		3	

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Question	Answer	Marks	Guidance															
2(a)	$P(1 \text{ red}) = \frac{5}{8} \times \frac{3}{7} \times \frac{2}{6} \times 3$	M1	$\frac{a}{8} \times \frac{b}{7} \times \frac{c}{6} \times k$ or $\frac{5}{d} \times \frac{3}{e} \times \frac{2}{f} \times 3$, $1 \leq a, b, c \leq 5$, $d, e, f \leq 8$, a, b, c, d, e, f, k all integers. $1 < k \leq 3$,															
	$\frac{15}{56}$	A1	AG, WWW															
	Alternative method for question 2(a)																	
	$\frac{{}^5C_1 \times {}^3C_2}{{}^8C_3}$	M1	$\frac{{}^aC_1 \times {}^bC_2}{{}^8C_3}$ or $\frac{{}^5C_d \times {}^3C_e}{{}^8C_3}$ or $\frac{{}^5C_d \times {}^3C_e \left(\text{or } {}^aC_1 \times {}^bC_2 \right)}{{}^5C_3 \times {}^3C_0 + {}^5C_2 \times {}^3C_1 + {}^5C_1 \times {}^3C_2 + {}^5C_0 \times {}^3C_3}$, $a + b = 8$, $d + e = 3$															
	$\frac{15}{56}$	A1	AG, WWW, $\frac{15}{56}$ must be seen															
		2																
2(b)	<table><tr><td>x</td><td>0</td><td>1</td><td>2</td><td>3</td></tr><tr><td>Prob.</td><td>$\frac{1}{56}$</td><td>$\frac{15}{56}$</td><td>$\frac{30}{56} = \frac{15}{28}$</td><td>$\frac{10}{56} = \frac{5}{28}$</td></tr><tr><td></td><td>0.0179</td><td>0.268</td><td>0.536</td><td>0.179</td></tr></table>	x	0	1	2	3	Prob.	$\frac{1}{56}$	$\frac{15}{56}$	$\frac{30}{56} = \frac{15}{28}$	$\frac{10}{56} = \frac{5}{28}$		0.0179	0.268	0.536	0.179	B1	Probability distribution table with correct outcomes with at least one probability less than 1, allow extra outcome values if probability of zero stated.
	x	0	1	2	3													
	Prob.	$\frac{1}{56}$	$\frac{15}{56}$	$\frac{30}{56} = \frac{15}{28}$	$\frac{10}{56} = \frac{5}{28}$													
		0.0179	0.268	0.536	0.179													
	B1	2 of P(0), P(2) and P(3) correct																
	B1 FT	4 th probability correct or FT sum of 3 or more probabilities = 1, with P(1) correct																
		3																

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Question	Answer	Marks	Guidance
2(c)	$\text{Var}(X) = \frac{(0^2 \times 1) + 1^2 \times 15 + 2^2 \times 30 + 3^2 \times 10}{56} - \left(\frac{15}{8}\right)^2$ $= \frac{15}{56} + \frac{120}{56} + \frac{90}{56} - \left(\frac{15}{8}\right)^2$	M1	Substitute <i>their</i> attempts at scores in correct variance formula, must have ‘– mean ² ’ (FT if mean calculated) (condone probabilities not summing to 1 for this mark)
	$\frac{225}{448}, 0.502$	A1	
		2	

Question	Answer	Marks	Guidance
3(a)	$P(X > 11.3) = P\left(z > \frac{11.3 - 10.1}{1.3}\right) = P(z > 0.9231)$	M1	Using $\pm$ standardisation formula, no $\sqrt{\sigma}$ or σ^2 , continuity correction
	$1 - 0.822$	M1	Appropriate area Φ , from standardisation formula $P(z > \dots)$ in final solution
	0.178	A1	$0.1779\dots$
		3	
3(b)	$z = -0.674$	B1	± 0.674 seen (critical value)
	$\frac{t - 10.1}{1.3} = -0.674$	M1	An equation using $\pm$ standardisation formula with a z-value, condone $\sqrt{\sigma}$ or σ^2 , continuity correction.
	$t = 9.22$	A1	AWRT. Only dependent on M1
		3	

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Question	Answer	Marks	Guidance
3(c)	$P(8.9 < X < 11.3) = 1 - 2 \times \text{their 3(a)}$ $\equiv 2(1 - \text{their 3(a)}) - 1$ $\equiv 2(0.5 - \text{their 3(a)})$ $= 0.644$	B1 FT	FT from <i>their 3(a)</i> < 0.5 or correct, accept unevaluated probability OE
	Number of days = 90×0.644 = 57.96	M1	$90 \times \text{their } p$ seen, $0 < p < 1$
	So 57 (days)	A1 FT	Accept 57 or 58, not 57.0 or 58.0, no approximation/rounding stated FT must be an integer value
	Alternative method for question 3(c)		
	$P\left(\frac{8.9 - 10.1}{1.3} < z < \frac{11.3 - 10.1}{1.3}\right)$ $= \Phi(0.9231) - (1 - \Phi(0.9231))$ oe $= 0.822 - (1 - 0.822)$ $= 0.644$	B1	Accept unevaluated probability
	Number of days = 90×0.644 = 57.96	M1	$90 \times \text{their } p$ seen, $0 < p < 1$
	So 57 (days)	A1 FT	Accept 57 or 58, not 57.0 or 58.0, no approximation/rounding stated FT must be an integer value
		3	

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Question	Answer	Marks	Guidance
4(a)	1 April 2 April 0.8 Fine 0.25 Fine 0.25 Rainy 0.2 Rainy 0.4 Fine 0.6 Rainy	B1	All probabilities correct, may be on branch or next to 'Fine/Rainy' Ignore additional branches.
		1	
4(b)	$0.8 \times 0.75 + 0.2 \times 0.4$ ($= 0.6 + 0.08$)	M1	Correct or FT from <i>their</i> diagram unsimplified, all probabilities $0 < p < 1$. Partial evaluation only sufficient when correct. Accept working in 4(b) or by the tree diagram.
	$0.68, \frac{17}{25}$	A1	From supporting working
		2	

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Question	Answer	Marks	Guidance
4(c)	$0.8 \times 0.75 \times 0.25 + 0.8 \times 0.25 \times 0.6$	M1	$a \times b \times c + a \times 1-b \times d$, $0 < c, d \leq 1$, a, b consistent with <i>their</i> tree diagram or correct, no additional terms
	$0.15 + 0.12$	A1	At least one term correct, accept unsimplified
	0.27	A1	Final answer
		3	
4(d)	$P(Y) = \text{their (c)} + 0.2 \times 0.4 \times 0.25 + 0.2 \times 0.6 \times 0.6$ (= 0.362)	B1 FT	$\text{their (c)} + e \times f \times g + e \times (1-f) \times h$, $0 < g, h \leq 1$, e, f consistent with <i>their</i> tree diagram, or correct
	$P(X Y) = \frac{\text{their (c)}}{\text{their } P(Y)} = \frac{0.27}{0.362}$	M1	<i>their</i> 4(c) (or correct)/ <i>their</i> previously calculated and identified $P(Y)$ or a denominator involving 3 or 4 3-factor probability terms consistent with <i>their</i> tree diagram & third factor $0 < p < 1$
	$0.746, \frac{373}{500}$ or $\frac{135}{181}$	A1	(0.7458...)
		3	

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Question	Answer			Marks	Guidance																																																									
5(a)	<table><tr><td colspan="3"><i>Dados</i></td><td></td><td colspan="3"><i>Linva</i></td></tr><tr><td>8</td><td>6</td><td>0</td><td>0</td><td>2</td><td>9</td></tr><tr><td>6</td><td>5</td><td>2</td><td>0</td><td>0</td><td>1</td><td>0</td><td>1</td><td>2</td><td>5</td><td>6</td></tr><tr><td>8</td><td>2</td><td>2</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>6</td><td>3</td><td>2</td><td>6</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>2</td><td>4</td><td>0</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr></table>			<i>Dados</i>				<i>Linva</i>			8	6	0	0	2	9	6	5	2	0	0	1	0	1	2	5	6	8	2	2									6	3	2	6								2	4	0									B1	Correct stem can be upside down, ignore extra values
	<i>Dados</i>				<i>Linva</i>																																																									
	8	6	0	0	2	9																																																								
	6	5	2	0	0	1	0	1	2	5	6																																																			
	8	2	2																																																											
	6	3	2	6																																																										
2	4	0																																																												
			B1	Correct Dados labelled, leaves in order and lined up vertically (less than midway to next column), no commas etc, no extra terms																																																										
			B1	Correct Linva on opposite side of stem labelled, leaves in order and lined up vertically (less than midway to next column), no commas etc, no extra terms																																																										
KEY 6 3 2 means 36 cm (snow) in Dados and 32 cm (snow) in Linva			B1	Correct single key for their diagram, need both resorts identified and ‘cm’ stated at least once here or in leaf headings or title. SC If 2 separate diagrams drawn, SCB1 if both keys meet these criteria B0B1B0SCB1 max.																																																										
			4																																																											
5(b)	Median or Q2 = 15 (cm)			B1	Correct																																																									
	UQ or Q3 = 28 cm, LQ or Q1 = 10 cm IQR = 28 – 10			M1	$22 \leq \text{UQ} \leq 36 - 8 \leq \text{LQ} \leq 10$																																																									
	18 (cm)			A1	WWW																																																									
				3																																																										
5(c)	On average the snowfall in Davos is higher			B1 FT	FT from <i>their</i> 5(b) values for Dados. Statement comparing central tendency in context																																																									
	The amount of snowfall in Linva varies more than in Davos			B1 FT	Statement comparing spread in context Note: simply stating and comparing the values is not sufficient.																																																									
				2																																																										

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Question	Answer	Marks	Guidance
6(a)	${}^9C_6 (\times {}^3C_3)$	M1	${}^9C_k \times n, k = 6, 3, n = 1, 2$ oe Condone ${}^9C_6 + {}^3C_3, {}^9P_6 \times {}^3P_3$
	84	A1	Accept unevaluated.
		2	
6(b)	Number with 3 Baker children = ${}^6C_2$ or 15	B1	Correct seen anywhere, not multiplied or added
	Total no of selections = ${}^9C_5$ or 126 Probability = $\frac{\text{number of selections with 3 Baker children}}{\text{total number of selections}}$	M1	Seen as denominator of fraction
	$\frac{15}{126}, 0.119$	A1	OE, e.g. $\frac{5}{42}$
	Alternative method for question 6(b)		
	$\frac{3}{9} \times \frac{2}{8} \times \frac{1}{7} \left(\times \frac{6}{6} \right) \left(\times \frac{5}{5} \right) \times {}^5C_3$	B1	${}^5C_3$ (OE) or 10 seen anywhere, multiplied by fractions only, not added
		M1	$\frac{3}{9} \times \frac{2}{8} \times \frac{1}{7} \left(\times \frac{6}{6} \right) \left(\times \frac{5}{5} \right) \times k, 1 \leq k, k \text{ integer}$
	$\frac{15}{126}, 0.119$	A1	OE, e.g. $\frac{5}{42}$
		3	

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Question	Answer	Marks	Guidance
6(c)	[Total no of arrangements = 9!] [Arrangements with men together = $8! \times 2$] Not together: $9! -$	M1	$9! - k$ or $362880 - k$, k an integer < 362 880
	$8! \times 2$	B1	$8! \times 2(!)$ or 80 640 seen anywhere
	282 240	A1	Exact value
	Alternative method for question 6(c)		
	$7! \times 8 \times 7$	B1	$7! \times k$, k positive integer > 1
		M1	$m \times 8 \times 7$, $m \times {}^8P_2$, $m \times {}^8C_2$ m positive integer > 1
	282 240	A1	Exact value
		3	
6(d)	$7! \times 2 \times 7$	M1	$7! \times k$, k positive integer > 1 If 7! not seen, condone $7 \times 6 \times 5 \times 4 \times 3 \times 2 \times (1) \times k$ or $7 \times 6! \times k$ only
		M1	$m \times 2 \times 7$, m positive integer > 1
	70 560	A1	
		3	



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.

Cambridge International is publishing the mark schemes for the October/November 2020 series for most Cambridge IGCSE™, Cambridge International A and AS Level and Cambridge Pre-U components, and some Cambridge O Level components.

This document consists of **14** 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 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.

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

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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 $\pm$ 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	$\pm(1.126 - 1.127)$ 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	

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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	

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Question	Answer	Marks	Guidance
3(a)	Scenarios: 6W 0M ${}^9C_6 = 84$ 5W 1M ${}^9C_5 \times {}^5C_1 = 126 \times 5 = 630$ 4W 2M ${}^9C_4 \times {}^5C_2 = 126 \times 10 = 1260$	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 ${}^nC_4$ seen on its own or subtracted from <i>their</i> total, $x \leq 6$, $n \leq 13$
	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) = ${}^{12}C_5 \times 2 (= 792 \times 2) = 1584$	M1	${}^{12}C_x \times 2$ or ${}^nC_5 \times 2$ seen on its own or added to <i>their</i> number of ways with neither, $x \leq 5$, $n \leq 12$
	Number required = $924 + 1584$ = 2508	A1	
		3	

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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)
	$P(X > 40) = P\left(z > \frac{40.5 - 49.7}{\sqrt{32.305}}\right)$	M1	Substituting <i>their</i> μ and σ (no $\sqrt{\sigma}$ or σ^2) into $\pm$ standardisation formula with a numerical value for '40.5'
	$P(z > -1.619)$	M1	Using either 40.5 or 39.5 within a $\pm$ standardisation formula
		M1	Appropriate area Φ , from standardisation formula $P(z > \dots)$ in final solution, must be probability
	0.947	A1	Correct final answer
		5	

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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 <i>their</i> $\frac{6!}{2 \times 2!}$ divided by <i>their</i> 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	

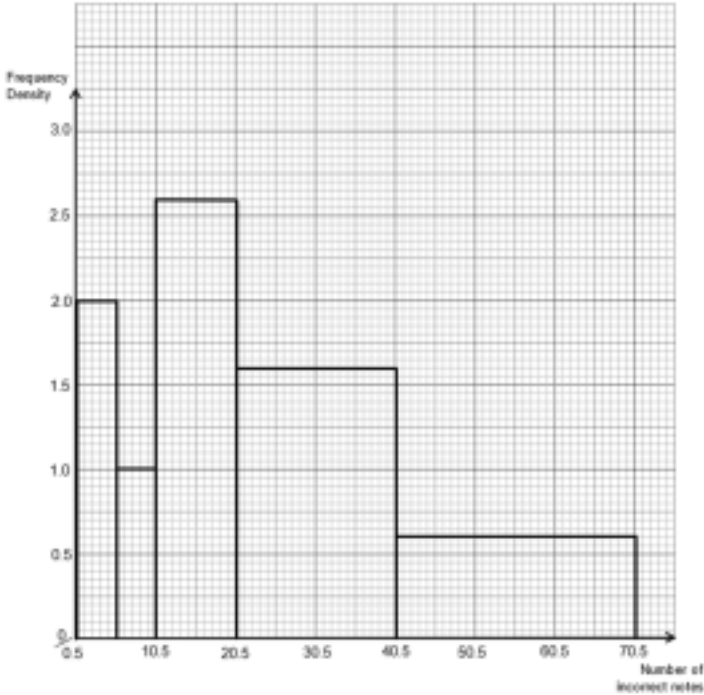
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Question	Answer	Marks	Guidance
5(b)	Rs together and Es together: $5!$ (120)	B1	Alone or as numerator of probability to represent the number of ways with Rs and Es together, no $\times$, +, –
	Es together: $\frac{6!}{2!}$ (= 360)	B1	Alone or as denominator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

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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)	<table border="1"><tr><td>x</td><td>0</td><td>1</td><td>2</td><td>3</td></tr><tr><td>Prob.</td><td>$\frac{1}{45}$</td><td>$\frac{8}{45}$</td><td>$\frac{20}{45}$</td><td>$\frac{16}{45}$</td></tr></table>	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'
	x	0	1	2	3								
	Prob.	$\frac{1}{45}$	$\frac{8}{45}$	$\frac{20}{45}$	$\frac{16}{45}$								
		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)	$\text{Var}(X) = \frac{0^2 \times 1 + 1^2 \times 8 + 2^2 \times 20 + 3^2 \times 16}{45} - \left(\frac{32}{15}\right)^2$ $= \frac{8}{45} + \frac{80}{45} + \frac{144}{45} - \left(\frac{32}{15}\right)^2$	M1	Substitute <i>their</i> 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											

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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 <i>their</i> 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 <i>their</i> LQ interval from upper end of <i>their</i> UQ interval
		2	

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Question	Answer	Marks	Guidance
7(c)	Midpoints: 3 8 15.5 30.5 55.5	M1	At least 4 midpoints correct and used
	$\text{Mean} = \frac{3 \times 10 + 8 \times 5 + 15.5 \times 26 + 30.5 \times 32 + 55.5 \times 18}{91}$ $= \frac{30 + 40 + 403 + 976 + 999}{91}$ $= \frac{2448}{91}$	M1	Correct formula with <i>their</i> 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	