



Cambridge International AS & A Level

MATHEMATICS

9709/51

Paper 5 Probability & Statistics 1

May/June 2020

MARK SCHEME

Maximum Mark: 50

Published

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This mark scheme is published to support teachers and students and should be read together with the question paper. It shows the requirements of the exam. The answer column of the mark scheme shows the proposed basis on which Examiners would award marks for this exam. Where appropriate, this column also provides the most likely acceptable alternative responses expected from students. Examiners usually review the mark scheme after they have seen student responses and update the mark scheme if appropriate. In the June series, Examiners were unable to consider the acceptability of alternative responses, as there were no student responses to consider.

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This document consists of **13** printed pages.

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.

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.

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.

Abbreviations

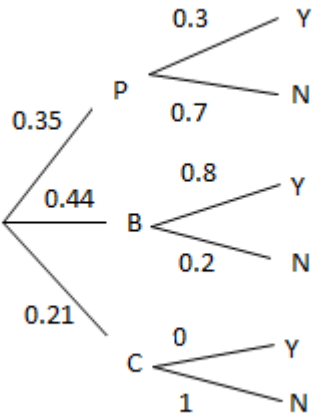
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CWO	Correct Working Only
ISW	Ignore Subsequent Working
SOI	Seen Or Implied
SC	Special Case (detailing the mark to be given for a specific wrong solution, or a case where some standard marking practice is to be varied in the light of a particular circumstance)
WWW	Without Wrong Working
AWRT	Answer Which Rounds To

Question	Answer	Marks
1(a)	Prob of 4 (from 1,3, 3,1 or 2,2) = $\frac{3}{36} = \frac{1}{12}$ AG	B1
		1
1(b)	Mean = $\frac{1}{\frac{1}{12}} = 12$	B1
		1
1(c)	$\left(\frac{11}{12}\right)^5 \times \frac{1}{12} = 0.0539$ or $\frac{161051}{2985984}$	B1
		1
1(d)	$1 - \left(\frac{11}{12}\right)^7$	M1
	0.456 or $\frac{16344637}{35831808}$	A1
		2

Question	Answer	Marks
2(a)	6!	M1
	720	A1
		2
2(b)	Total number: $\frac{9!}{3!2!}(30240)$	M1
	Number with Ls together = $\frac{8!}{3!}(6720)$	M1
	Number with Ls not together = $\frac{9!}{3!2!} - \frac{8!}{3!}$ = 30 240 – 6720	M1
	23 520	A1
	Alternative method for question 2(b)	
	$\frac{7!}{3!} \times \frac{8 \times 7}{2}$	
	$7! \times k$ in numerator, k integer ≥ 1	M1
	$8 \times 7 \times m$ in numerator or $8C2 \times m$, m integer ≥ 1	M1
	3! in denominator	M1
	23 520	A1
		4

Question	Answer					Marks										
3(a)	<table><tr><td>x</td><td>0</td><td>1</td><td>2</td><td>3</td></tr><tr><td>Probability</td><td>$\frac{1}{56}$</td><td>$\frac{15}{56}$</td><td>$\frac{30}{56}$</td><td>$\frac{10}{56}$</td></tr></table>					x	0	1	2	3	Probability	$\frac{1}{56}$	$\frac{15}{56}$	$\frac{30}{56}$	$\frac{10}{56}$	B1
	x	0	1	2	3											
	Probability	$\frac{1}{56}$	$\frac{15}{56}$	$\frac{30}{56}$	$\frac{10}{56}$											
	(B1 for probability distribution table with correct outcome values)															
	$P(0) = \frac{3}{8} \times \frac{2}{7} \times \frac{1}{6} = \frac{1}{56}$ $P(1) = \frac{5}{8} \times \frac{3}{7} \times \frac{2}{6} \times 3 = \frac{15}{56}$ $P(2) = \frac{5}{8} \times \frac{4}{7} \times \frac{3}{6} \times 3 = \frac{30}{56}$ $P(3) = \frac{5}{8} \times \frac{4}{7} \times \frac{3}{6} = \frac{10}{56}$ (M1 for denominator 8×7×6)					M1										
	Any one probability correct (with correct outcome)					A1										
All probabilities correct					A1											
					4											
3(b)	$1 - P(8, 9, 10) = 1 - \left[{}^{10}C_8 0.64^8 0.36^2 + {}^{10}C_9 0.64^9 0.36^1 + 0.64^{10} \right]$					M1										
	$1 - (0.164156 + 0.064852 + 0.11529)$					M1										
	0.759					A1										
						3										

Question	Answer	Marks
4	Scenarios: 2P 3V 2G ${}^8C_2 \times {}^4C_2 \times {}^6C_3 = 28 \times 6 \times 20 = 3360$ 2P 4V 1G ${}^8C_2 \times {}^4C_1 \times {}^6C_4 = 28 \times 4 \times 15 = 1680$ 3P 3V 1G ${}^8C_3 \times {}^4C_1 \times {}^6C_3 = 56 \times 4 \times 20 = 4480$ 4P 2V 1G ${}^8C_4 \times {}^4C_1 \times {}^6C_2 = 70 \times 4 \times 15 = 4200$ (M1 for ${}^8C_r \times {}^4C_r \times {}^6C_r$ with $\sum r = 7$)	M1
	Two unsimplified products correct	B1
	Summing the number of ways for 3 or 4 correct scenarios	M1
	Total: 13 720	A1
		4

Question	Answer	Marks
5(a)	 Fully correct labelled tree for method of transport with correct probabilities.	B1
	Fully correct labelled branches with correct probabilities for lateness with either 1 branch after W or 2 branches with the prob 0	B1
		2
5(b)	$0.35 \times 0.3 + 0.44 \times 0.8 (+ 0)$	M1
	0.457	A1
		2

Question	Answer	Marks
5(c)	$P(\text{not B} \text{not fruit}) = \frac{P(B' \cap F')}{P(F')}$	M1
	$\frac{0.35 \times 0.7 + 0.21 \times 1}{1 - \text{their}(\mathbf{b})}$	M1
	$\frac{0.455}{0.543}$ (M1 for $1 - \text{their}(\mathbf{b})$ or summing three appropriate 2-factor probabilities, correct or consistent with <i>their</i> tree diagram as denominator)	M1
	0.838 or $\frac{455}{543}$	A1
		4

Question	Answer	Marks
6(a)	$P\left(\frac{50 - 54}{6.1} < z < \frac{60 - 54}{6.1}\right) = P(-0.6557 < Z < 0.9836)$	M1
	Both values correct	A1
	$\Phi(0.9836) - \Phi(-0.6557) = \Phi(0.9836) + \Phi(0.6557) - 1$ $= 0.8375 + 0.7441 - 1$ (Correct area)	M1
	0.582	A1
		4

Question	Answer	Marks
6(b)	$\frac{45 - \mu}{\sigma} = -0.994$	B1
	$\frac{56 - \mu}{\sigma} = 1.372$	B1
	One appropriate standardisation equation with μ, σ , z-value (not probability) and 45 or 56.	M1
	$11 = 2.366 \sigma$ (M1 for correct algebraic elimination of μ or σ from <i>their</i> two simultaneous equations to form an equation in one variable)	M1
	$\sigma = 4.65, \mu = 49.6$	A1
		5

Question	Answer	Marks
7(a)	Class widths: 10, 5, 15, 20, 10	M1
	Frequency density = frequency/ <i>their</i> class width: 1.8, 4.8, 2, 1, 0.8	M1
	All heights correct on diagram (using a linear scale)	A1
	Correct bar ends	B1
	Bar ends: 10.5, 15.5, 30.5, 50.5, 60.5	B1
		5
7(b)	11 – 15 and 31 – 50	B1
	Greatest IQR = 50 – 11 = 39	B1
		2
7(c)	Mean = $\frac{18 \times 5.5 + 24 \times 13 + 30 \times 23 + 20 \times 40.5 + 8 \times 55.5}{100} = \frac{2355}{100} = 23.6$	B1
	Var = $\frac{18 \times 5.5^2 + 24 \times 13^2 + 30 \times 23^2 + 20 \times 40.5^2 + 8 \times 55.5^2}{100} - \text{mean}^2$	M1
	$\frac{77917.5}{100} - \text{mean}^2 = 224.57$	A1
	Standard deviation = 15.0 (FT <i>their</i> variance)	A1 FT
		4



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Question	Answer	Marks
1	$\sum x - 50n = 144$	B1
	$50n + 144 = 944$	M1
	$n = 16$	A1
		3

Question	Answer	Marks
2(a)	$\frac{56}{500}$ or $\frac{14}{125}$ or 0.112	B1
		1
2(b)	$P(D S) = \frac{P(D \cap S)}{P(S)} = \frac{120}{280}$	M1
	$\frac{120}{280}$ or $\frac{3}{7}$	A1
		2

Question	Answer	Marks
2(c)	$P(\text{hockey}) = \frac{220}{500} = 0.44$ $P(\text{Amos or Benn}) = \frac{242}{500} = 0.484$ $P(\text{hockey} \cap A \text{ or } B) = \frac{104}{500} = 0.208$ $P(H) \times P(A \cup B) = P(H \cap (A \cup B))$ if independent	M1
	$\frac{220}{500} \times \frac{242}{500} = \frac{1331}{6250}$ so not independent	A1
		2

Question	Answer	Marks
3(a)	Median = 0.238	B1
	UQ = 0.245, LQ = 0.231, So IQR = 0.245 – 0.231	M1
	0.014	A1
		3

Question	Answer						Marks																		
3(b)	<table><tr><td></td><td></td><td>LQ</td><td>M</td><td>UQ</td><td></td></tr><tr><td>A</td><td>0.220</td><td>0.231 FT</td><td>0.238 FT</td><td>0.245 FT</td><td>0.254</td></tr><tr><td>B</td><td>0.211</td><td>0.224</td><td>0.232</td><td>0.243</td><td>0.256</td></tr></table>								LQ	M	UQ		A	0.220	0.231 FT	0.238 FT	0.245 FT	0.254	B	0.211	0.224	0.232	0.243	0.256	
			LQ	M	UQ																				
	A	0.220	0.231 FT	0.238 FT	0.245 FT	0.254																			
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	Medians and quartiles correctly plotted for A or B						B1																		
	End points correct for A or B						B1																		
Completely correct, including scale						B1																			
						3																			
3(c)	Lengths of rods produced by machine A are longer. (B1 for comparison of central tendency)						B1																		
	Lengths of rods produced by machine A are less spread out (B1 for comparison of spread)						B1																		
							2																		

Question	Answer	Marks
4(a)	$P(X < 25) = P\left(z < \frac{25 - 40}{12}\right) = P(z < -1.25) P(X < 25) = P(z <)$	M1
	$1 - 0.8944$	M1
	0.106	A1
		3
4(b)	0.8944 divided by 3 (M1 for 1 - <i>their</i> (a) divided by 3)	M1
	0.298 AG	A1
		2
4(c)	0.2981 gives $z = 0.53$	B1
	$\frac{h - 40}{12} = 0.53$	M1
	$h = 46.4$	A1
		3

Question	Answer					Marks																								
5(a)	<table><tr><td></td><td>1</td><td>1</td><td>2</td><td>2</td><td>3</td></tr><tr><td>1</td><td>1</td><td>1</td><td>2</td><td>2</td><td>3</td></tr><tr><td>2</td><td>2</td><td>2</td><td>2</td><td>2</td><td>3</td></tr><tr><td>3</td><td>3</td><td>3</td><td>3</td><td>3</td><td>3</td></tr></table>						1	1	2	2	3	1	1	1	2	2	3	2	2	2	2	2	3	3	3	3	3	3	3	M1
		1	1	2	2	3																								
	1	1	1	2	2	3																								
2	2	2	2	2	3																									
3	3	3	3	3	3																									
	$\frac{7}{15}$ AG					A1																								
						2																								
5(b)	<table><tr><td>x</td><td>1</td><td>2</td><td>3</td></tr><tr><td>Probability</td><td>$\frac{2}{15}$</td><td>$\frac{6}{15}$</td><td>$\frac{7}{15}$</td></tr></table>					x	1	2	3	Probability	$\frac{2}{15}$	$\frac{6}{15}$	$\frac{7}{15}$	B1																
	x	1	2	3																										
	Probability	$\frac{2}{15}$	$\frac{6}{15}$	$\frac{7}{15}$																										
	P(1) or P(2) correct					B1																								
3 rd probability correct, FT sum to 1					B1																									
						3																								

Question	Answer	Marks
5(c)	$E(X) = \frac{2+12+21}{15} = \frac{35}{15} = \frac{7}{3}$	B1
	$\text{Var}(X) = \frac{1^2 \times 2 + 2^2 \times 6 + 3^2 \times 7}{15} - \left(\frac{7}{3}\right)^2$	M1
	$\frac{22}{45} (0.489)$	A1
		3

Question	Answer	Marks
6(a)	$\frac{8!}{3!}$	M1
	6720	A1
		2

Question	Answer	Marks
6(b)	Total number = $\frac{10!}{2!3!}$ (302400) (A)	B1
	With Es together = $\frac{9!}{3!}$ (60480) (B)	B1
	Es not together = <i>their</i> (A) – <i>their</i> (B)	M1
	241920	A1
	Alternative method for question 6(b)	
	$\begin{array}{cccccccc} \wedge & \wedge & \wedge & \wedge & \wedge & \wedge & \wedge & \wedge \\ \frac{8!}{3!} \times \frac{9 \times 8}{2} \end{array}$	
	$8! \times k$ in numerator, k integer ≥ 1 , denominator ≥ 1	B1
	$3! \times m$ in denominator, m integer ≥ 1	B1
	<i>Their</i> $\frac{8!}{3!}$ Multiplied by ${}^9C_2$ (OE) only (no additional terms)	M1
	241920	A1
		4

Question	Answer	Marks
6(c)	Scenarios: E M M M ${}^5C_0 = 1$ E M M _ ${}^5C_1 = 5$ E M _ _ ${}^5C_2 = 10$	M1
	Summing the number of ways for 2 or 3 correct scenarios	M1
	Total = 16	A1
		3

Question	Answer	Marks
7(a)	$1 - P(10, 11, 12)$ $= 1 - [{}^{12}C_{10} 0.72^{10} 0.28^2 + {}^{12}C_{11} 0.72^{11} 0.28^1 + 0.72^{12}]$	M1
	$1 - (0.19372 + 0.09057 + 0.01941)$	A1
	0.696	A1
		3
7(b)	$0.28^3 \times 0.72 = 0.0158$	B1
		1

Question	Answer	Marks
7(c)	Mean = $100 \times 0.72 = 72$ Var = $100 \times 0.72 \times 0.28 = 20.16$	M1
	$P(\text{less than } 64) = P\left(z < \frac{63.5 - 72}{\sqrt{20.16}}\right)$ (M1 for substituting <i>their</i> μ and σ into $\pm$ standardisation formula with a numerical value for '63.5')	M1
	Using either 63.5 or 64.5 within a $\pm$ standardisation formula	M1
	Appropriate area Φ , from standardisation formula $P(z < \dots)$ in final solution = $P(z < -1.893)$	M1
	0.0292	A1
		5



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- 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, 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.

Mark Scheme Notes

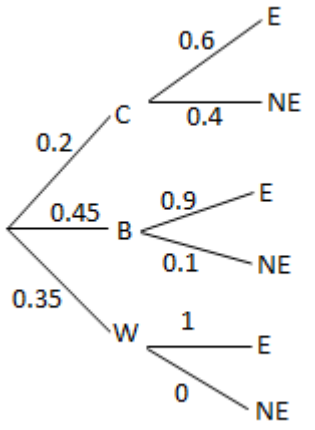
The following notes are intended to aid interpretation of mark schemes in general, but individual mark schemes may include marks awarded for specific reasons outside the scope of these notes.

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.

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

Question	Answer	Marks
1(a)	 Fully correct labelled tree for method of transport with correct probabilities.	B1
	Fully correct labelled branches with correct probabilities for lateness with either 1 branch after W or 2 branches with the probability 0.	B1
		2
1(b)	$P(C E) = \frac{P(C \cap E)}{P(E)} = \frac{0.2 \times 0.6}{0.2 \times 0.6 + 0.45 \times 0.1 + 0.35 \times 1}$	M1
	Summing three appropriate 2-factor probabilities	M1
	$\frac{0.12}{0.515}$	A1
	$0.233 \text{ or } \frac{12}{515}$	A1
		4

Question	Answer	Marks
2(a)	$0.22^3 = 0.0106$	B1
		1
2(b)	$P(2, 3, 4) = {}^{16}C_2 0.22^2 0.78^{14} + {}^{16}C_3 0.22^3 0.78^{13} + {}^{16}C_4 0.22^4 0.78^{12}$	M1
	$0.179205 + 0.235877 + 0.216221$	A1
	0.631	A1
		3

Question	Answer	Marks
3(a)	$P(X < 21) = P\left(z < \frac{21 - 15.8}{4.2}\right) = \Phi(1.238)$	M1
	0.892	A1
		2
3(b)	$z = \pm 0.674$	B1
	$\frac{k - 15.8}{4.2} = 0.674$	M1
	18.6	A1
		3

Question	Answer	Marks														
4(a)	<table><tr><td>−1</td><td>0</td><td>0</td><td>1</td></tr><tr><td>0</td><td>1</td><td>1</td><td>2</td></tr><tr><td>2</td><td>3</td><td>3</td><td>4</td></tr></table>	−1	0	0	1	0	1	1	2	2	3	3	4			
	−1	0	0	1												
	0	1	1	2												
	2	3	3	4												
	<table><tr><td>x</td><td>−1</td><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td></tr><tr><td>Probability</td><td>$\frac{1}{12}$</td><td>$\frac{3}{12}$</td><td>$\frac{3}{12}$</td><td>$\frac{2}{12}$</td><td>$\frac{2}{12}$</td><td>$\frac{1}{12}$</td></tr></table>	x	−1	0	1	2	3	4	Probability	$\frac{1}{12}$	$\frac{3}{12}$	$\frac{3}{12}$	$\frac{2}{12}$	$\frac{2}{12}$	$\frac{1}{12}$	
	x	−1	0	1	2	3	4									
Probability	$\frac{1}{12}$	$\frac{3}{12}$	$\frac{3}{12}$	$\frac{2}{12}$	$\frac{2}{12}$	$\frac{1}{12}$										
Probability distribution table with correct scores with at least one probability	B1															
At least 4 probabilities correct	B1															
All probabilities correct	B1															
	3															
4(b)	$E(X) = \frac{-1+0+3+4+6+4}{12} = \frac{16}{12} = \frac{4}{3}$	B1														
	$Var(X) = \frac{1+0+3+8+18+16}{12} - \left(\frac{4}{3}\right)^2$	M1														
	$\frac{37}{18}$ (= 2.06)	A1														
		3														

Question	Answer	Marks
5(a)	$\frac{1}{\frac{1}{4}} = 4$	B1
		1
5(b)	$\frac{9}{64}$ (= 0.141)	B1
		1
5(c)	$P(X < 6) = 1 - \left(\frac{3}{4}\right)^5$ (FT <i>their</i> probability/mean from part (a))	M1
	0.763	A1
		2
5(d)	Mean = $80 \times 0.25 = 20$ Var = $80 \times 0.25 \times 0.75 = 15$	M1
	$P(\text{more than } 25) = P\left(z > \frac{25.5 - 20}{\sqrt{15}}\right)$	M1
	$P(z > 1.42)$	M1
	$1 - 0.9222$	M1
	0.0778	A1
		5

Question	Answer	Marks																		
6(a)	<table><tr><td>A</td><td></td><td>B</td></tr><tr><td></td><td>2</td><td>6</td></tr><tr><td>5 2 0</td><td>3</td><td>0 1 5 8</td></tr><tr><td>9 7 2 1 1</td><td>4</td><td>1 2 2 7 9</td></tr><tr><td>3 2</td><td>5</td><td>2</td></tr><tr><td>4</td><td>6</td><td></td></tr></table> KEY 1 4 2 means \$41 000 for A and \$42 000 for B Correct stem	A		B		2	6	5 2 0	3	0 1 5 8	9 7 2 1 1	4	1 2 2 7 9	3 2	5	2	4	6		B1
	A		B																	
		2	6																	
	5 2 0	3	0 1 5 8																	
	9 7 2 1 1	4	1 2 2 7 9																	
	3 2	5	2																	
4	6																			
Correct A on LHS	B1																			
Correct B on same diagram	B1																			
Correct key for <i>their</i> diagram, both companies identified and correct units	B1																			
	4																			
6(b)	Median = [\$]42 000	B1																		
	LQ = [\$]35 000 UQ = [\$]52 000	B1																		
	IQR = [\$]17 000 (FT if $49000 \leq UQ \leq 53000 - 32000 \leq LQ \leq 41000$)	B1 FT																		
		3																		

Question	Answer	Marks
6(c)	Sum of given 11 numbers is 433 000	M1
	Sum of 12 numbers, including new = $38\,500 \times 12 = 462\,000$	M1
	Difference = new salary = [\$]29 000	A1
		3

Question	Answer	Marks
7(a)	$\frac{9!}{2!2!} = 90\,720$	B1
		1
7(b)	$\frac{6!}{2!}$	M1
	360	A1
		2

Question	Answer	Marks
7(c)	2 Es together = $\frac{8!}{2!}$ (= 20160)	M1
	Es not together = $90720 - 20160 = 70560$	M1
	Probability = $\frac{70560}{90720}$	M1
	$\frac{7}{9}$ or 0.778	A1
	Alternative method for question 7(c)	
	$\begin{array}{cccccccc} & ^ & ^ & ^ & ^ & ^ & ^ & ^ \\ - & - & - & - & - & - & - & - \end{array}$ $\frac{7!}{2!} \times \frac{8 \times 7}{2} = 70560$	
	$7! \times k$ in numerator, k integer ≥ 1 , denominator ≥ 1	M1
	Multiplying by ${}^8C_2$ OE	M1
	Probability = $\frac{70560}{90720}$	M1
	$\frac{7}{9}$ or 0.778	A1
		4

Question	Answer	Marks
7(d)	Scenarios are: E L _ _ _ ${}^5C_3$ 10 E E L _ _ ${}^5C_2$ 10 E _ _ _ _ ${}^5C_4$ 5 E E _ _ _ ${}^5C_3$ 10	M1
	Summing the number of ways for 3 or 4 correct scenarios	M1
	Total = 35	A1
		3