
MATHEMATICS

9709/61

Paper 6

October/November 2019

MARK SCHEME

Maximum Mark: 50

Published

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This document consists of **12** 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.

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.

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	$0.8 \times 0.6 + 0.2(1 - x) = 0.63$	M1	Equation of form $0.8 \times A + 0.2 \times B = C$, A,B involving $1 - x$ and 0.6 or 0.4 and $C = 0.63$ or 0.37
	$0.2x = 0.05$	M1	Correct unsimplified equation
	$x = 0.25$	A1	
	Alternative method for question 1		
	$0.8 \times 0.4 + 0.2x = 1 - 0.63$	M1	Equation of form $0.8 \times A + 0.2 \times B = C$, A,B involving x and 0.6 or 0.4 and $C = 0.63$ or 0.37
	$0.2x = 0.05$	M1	Correct unsimplified equation
	$x = 0.25$	A1	
		3	

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Question	Answer	Marks	Guidance
2(i)	$1 - ({}^{10}C_2 0.42^8 0.58^2 + {}^{10}C_9 0.42^9 0.58^1 + 0.42^{10})$	M1	Binomial term of form ${}^{10}C_a p^a (1-p)^b$ $0 < p < 1$ any p , $0 \leq a, b \leq 10$
		A1	Correct unsimplified expression
	0.983	A1	
		3	
2(ii)	$1 - P(0) > 0.995 \quad 0.58^n < 0.005$	M1	Equation or inequality involving 0.58^n or 0.42^n and 0.995 or 0.005
	$n > \frac{\log 0.005}{\log 0.58}$ $n > 9.727$	M1	Attempt to solve using logs or Trial and Error. May be implied by their answer (rounded or truncated)
	$n = 10$	A1	CAO
		3	

Question	Answer	Marks	Guidance
3(i)	$\sum x = 60 \times 20 = 1200$	B1	
	$\frac{\sum x^2}{20} - 60^2 = 4^2$	M1	Correct variance formula used, condone = 4
	$\sum x^2 = 3616 \times 20 = 72320$	A1	Exact value
		3	

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Question	Answer	Marks	Guidance
3(ii)	$\Sigma x = 1200 + 550 = 1750$ $\Sigma x^2 = 72320 + 40500 = 112800$	M1	Summing both values of Σx and Σx^2
	Mean = $\frac{\text{their } 1750}{30} = 58.3$	B1FT	FT <i>their</i> 1750 (not 550 or 1200)/ <i>their</i> (20+10), accept unsimplified
	Variance = $\frac{\text{their } 112820}{30} - \left(\frac{\text{their } 1750}{30}\right)^2 (= 357.89)$	M1	substitute <i>their</i> Σx and Σx^2 into correct variance formula
	s.d. = 18.9	A1	
		4	

Question	Answer	Marks	Guidance
4(i)	$\frac{1}{4} + p + p + \frac{3}{8} + 4p = 1$	M1	Unsimplified sum of probabilities equated to 1
	$p = \frac{1}{16}$	A1	If method FT from <i>their</i> incorrect (i) , expressions for E(X) and Var(X) must be seen unsimplified with all probabilities <1, condone not adding to 1
		2	

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Question	Answer	Marks	Guidance
4(ii)	$[E(X)] = -\frac{1}{4} + \frac{1}{16} + \frac{6}{8} + 1 = \frac{25}{16}$	M1	May be implied by use in Variance, accept unsimplified
	$[\text{Var}(X)] = \frac{1}{4} + \frac{1}{16} + \frac{12}{8} + \frac{16}{4} - \left(\text{their } \frac{25}{16} \right)^2$	M1	Substitute into correct variance formula, must have ‘– their mean ² ’
	$\frac{863}{256}$ or 3.37	A1	OE
		3	
4(iii)	$P(X = 2 X > 0) = \frac{P(X = 2)}{P(X > 0)} = \frac{\frac{3}{8}}{\frac{11}{16}}$	M1	Conditional probability formula used consistent with their probabilities
	$\frac{6}{11}$ or 0.545	A1	
		2	

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Question	Answer	Marks	Guidance
5(i)	$156 - 55 = 99$	B1	$98 \leq \text{answer} < 100$
		1	
5(ii)	90% of 160 = 144	M1	144 seen, may be marked on graph
	(L =) 22	A1	
		2	
5(iii)	Median = 15.6 UQ = 18.8, LQ = 12.7	B1	$15.5 < \text{median} < 15.8$
	IQR = $18.8 - 12.7$	M1	$18.5 < \text{UQ} < 19 - 12.5 < \text{LQ} < 13$
	6.1	A1	$6.0 \leq \text{IQR} \leq 6.2$
		3	
5(iv)	The Median higher for Ransha (1st set of data)	B1	Any correct comparison of central tendency, must mention median
	IQR lower for Ransha (1st set of data)	B1	Any correct comparison of spread, must refer to IQR
		2	

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Question	Answer	Marks	Guidance
6(i)	$\frac{9!}{2!} = 181\,440$	B1	Exact value
		1	
6(ii)	Total no of ways = $\frac{12!}{2!4!} = 9\,979\,200$ (A)	B1	Accept unevaluated
	With Ss together = $\frac{11!}{4!} = 1\,663\,200$ (B)	B1	Accept unevaluated
	With Ss not together = (B) – (A)	M1	Correct or $\frac{12!}{m} - \frac{8!}{n}$, m, n integers > 1 or <i>their</i> identified total – <i>their</i> identified Ss together
	8 316 000	A1	Exact value
	Alternative method for question 6(ii)		
	_ T _ E _ E _ P _ L _ E _ C _ H _ A _ E _	B1	$10! \times k$ in numerator k integer ≥ 1
	$\frac{10!}{4!} \times \frac{11 \times 10}{2!}$	B1	$4! \times k$ in numerator k integer ≥ 1
	$\frac{\text{their } 10!}{\text{their } 4!} \times {}^{11}C_2$ or ${}^{11}P_2$	M1	OE
	8 316 000	A1	Exact value
		4	

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Question	Answer	Marks	Guidance
6(iii)	S E E E : 1	M1	${}^6C_x$ seen alone or times $K > 1$
	S E E _ : ${}^6C_1 = 6$ S E _ _ : ${}^6C_2 = 15$ S _ _ _ : ${}^6C_3 = 20$	B1	${}^6C_3$ or ${}^6C_2$ or ${}^6C_1$ alone
	Add 3 or 4 correct scenarios	M1	No extras
	Total = 42	A1	
		4	

Question	Answer	Marks	Guidance
7(i)	$P(46 < X < 53) = P\left(\frac{46 - 49.2}{2.8} < Z < \frac{53 - 49.2}{2.8}\right)$	M1	Using $\pm$ standardisation formula for either 46 or 53, no continuity correction, σ^2 or $\sqrt{\sigma}$
	$P(-1.143 < Z < 1.357)$	A1	Both standardisations correct unsimplified
	$\Phi(1.357) + \Phi(1.143) - 1$ $= 0.9126 + 0.8735 - 1$	M1	Correct final area
	0.786	A1	Final answer
		4	

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Question	Answer	Marks	Guidance
7(ii)	$\frac{t - 49.2}{2.8} = -1.406$	B1	± 1.406 seen
		M1	An equation using $\pm$ standardisation formula with a z-value, condone σ^2 or $\sqrt{\sigma}$
	45.3	A1	
		3	
7(iii)	$P(X < 46) = 0.1265$	M1	Calculated or ft from (i)
	$P(2PB < 46) = 3(1 - 0.1265)0.1265^2$	M1	$3(1-p)p^2$, $0 < p < 1$
	0.0419	A1	
		3	

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WWW	Without Wrong Working
AWRT	Answer Which Rounds To
NFWW	Not From Wrong Working

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Question	Answer	Marks	Guidance
1(i)	Median = 51 UQ = 57.5, LQ = 40	B1	
	IQR = UQ – LQ	M1	$55 \leq \text{UQ} \leq 62 - 38 \leq \text{LQ} \leq 45$
	17.5	A1	NFWW
		3	
1(ii)	Result will be disproportionately affected by 110	B1	Affected by an extreme/large value There is a large outlier ...contains outliers such as 110... Not ‘mean affected by extreme values’
		1	

Question	Answer	Marks	Guidance
2(i)	$0.4x + 0.6 \times 2x = 0.36$ or $0.4(1 - x) + 0.6(1 - 2x) = 0.64$	M1	$0.4a + (1 - 0.4)b = 0.36$ or 0.64 , a, b terms involving x
	$1.6x = 0.36$ $x = 0.225$	A1	Fully justified by algebra AG
		2	

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Question	Answer	Marks	Guidance
2(ii)	$P(H L) = \frac{0.4(1-x)}{1-0.36} = \frac{0.4 \times (1-0.225)}{0.64} = \frac{0.4 \times 0.775}{0.4 \times 0.775 + 0.6 \times 0.55}$	M1	Correct numerical numerator of a fraction. Allow unsimplified.
		M1	Denominator 0.36 or 0.64. Allow unsimplified.
	$\frac{31}{64}$ or 0.484	A1	
		3	

Question	Answer	Marks	Guidance
3(i)	0.5 2.4 3 1.4 0.4	M1	At least 3 frequency densities calculated (frequency ÷ class width) e.g. $\left(\frac{10}{20}, \frac{10}{19} \text{ or } \frac{10}{19.5}\right)$ may be read from graph using <i>their</i> scale, 3SF or exact
	All heights correct on graph.	A1	
	Bar ends of 9.5, 29.5, 39.5, 59.5, 89.5	B1	
	Axes labelled: Frequency density (fd) and speed/km h ⁻¹ (or appropriate title). Linear scales $9.5 \leq \text{horizontal axis} \leq 89.5$, $0 \leq \text{vertical axis} \leq 3$, 5 bars with no gaps	B1	
		4	

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Question	Answer	Marks	Guidance
3(ii)	$\frac{19.5 \times 10 + 34.5 \times 24 + 44.5 \times 30 + 54.5 \times 14 + 74.5 \times 12}{90}$ <i>their 90</i> $= \frac{195 + 828 + 1335 + 763 + 894}{90}$ $= \frac{4015}{90} \text{ or } \frac{803}{18}$	M1	Uses at least 4 midpoint attempts (e.g. 19.5 ± 0.5). Allow unsimplified expression.
	$44\frac{11}{18}$ or 44.6 (km h ⁻¹)	A1	Final answer not an improper fraction NFWW
		2	

Question	Answer	Marks	Guidance
4(i)	$P(8, 9, 10) = {}^{10}C_8 0.66^8 0.34^2 + {}^{10}C_9 0.66^9 0.34^1 + 0.66^{10}$	M1	Correct binomial term, ${}^{10}C_a 0.66^a (1-0.66)^b$ $a+b = 10, 0 < a, b < 10$
		A1	Correct unsimplified expression
	0.284	B1	CAO
		3	

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Question	Answer	Marks	Guidance
4(ii)	$np = 0.66 \times 150 = 99$ $npq = 0.66 \times (1 - 0.66) \times 150 = 33.66$	B1	Accept evaluated or unsimplified μ, σ^2 numerical expressions, condone $\sigma = \sqrt{33.66} = 5.8017$ or 5.802 CAO
	$P(X > 84) = P\left(Z > \frac{84.5 - 99}{\sqrt{33.66}}\right)$	M1	$\pm$ Standardise, $\frac{x - \text{their } 99}{\sqrt{\text{their } 33.66}}$, condone σ^2 , x a value
		M1	84.5 or 83.5 used in <i>their</i> standardisation formula
	$(= P(Z > -2.499))$	M1	Correct final area
	0.994	A1	Final answer (accept 0.9938) SC if no standardisation formula seen, B2 $P(Z > -2.499) = 0.994$
		5	

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Question	Answer	Marks	Guidance														
5(i)	<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>p</td><td>$\frac{1}{12}$</td><td>$\frac{1}{12}$</td><td>$\frac{3}{12}$</td><td>$\frac{2}{12}$</td><td>$\frac{3}{12}$</td><td>$\frac{2}{12}$</td></tr></table>	x	-1	0	1	2	3	4	p	$\frac{1}{12}$	$\frac{1}{12}$	$\frac{3}{12}$	$\frac{2}{12}$	$\frac{3}{12}$	$\frac{2}{12}$	B1	Table with correct values of x , at least 1 probability, all probabilities ≤ 1
	x	-1	0	1	2	3	4										
	p	$\frac{1}{12}$	$\frac{1}{12}$	$\frac{3}{12}$	$\frac{2}{12}$	$\frac{3}{12}$	$\frac{2}{12}$										
		B1	2 probabilities correct, may not be in table														
		B1	2 more probabilities correct, may not be in table														
	B1	All correct, values in table SC1 No more than 1 correct probability and at least 5 probabilities summing to 1 in table															
	4																
5(ii)	$[E(X)] = \left(\frac{-1+0+3+4+9+8}{12} \right) = \frac{23}{12}$	M1	May be implied by use in variance. Allow unsimplified expression														
	$[Var(X)] = \frac{1+0+3+8+27+32(=71)}{12} - \left(\frac{23}{12} \right)^2$	M1	Appropriate variance formula using <i>their</i> $E(X)^2$														
	2.24 or $\frac{323}{144}$ or $2\frac{35}{144}$	A1	CAO														
		3															

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Question	Answer	Marks	Guidance
6(i)	$P(X < 45) = P\left(Z < \frac{45 - 40}{8}\right)$ $= P(Z < 0.625)$	M1	$\pm$ Standardise, no continuity correction, σ^2 or $\sqrt{\sigma}$, formula must be seen
	0.734(0)	A1	CAO
		2	
6(ii)	$1 - 2(1 - (i)) = 2(i) - 1 = 2((i) - 0.5)$	M1	Use result of part (i) or recalculated to find area OE
	0.468	A1ft	0 < FT from (i) < 1 or correct.
		2	
6(iii)	$P(X < 10) = 48/500 = 0.096$ $z = -1.305$	B1	$z = \pm 1.305$
	$P(X > 24) = 76/500 = 0.152$ $z = 1.028$	B1	$z = \pm 1.028$
	$10 - \mu = -1.305\sigma$ $24 - \mu = 1.028\sigma$	M1	Form 1 equation using 10 or 24 with μ, σ, z -value. Allow continuity correction, not $\sigma^2, \sqrt{\sigma}$
	$14 = 2.333\sigma$	M1	OE Solve two equations in σ and μ to form equation in one variable
	$\sigma = 6.[00], \mu = 17.8[3]$	A1	CAO, WWW
		5	

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Question	Answer	Marks	Guidance
7(i)	$6! = 720$	B1	Evaluated
		1	
7(ii)	Total no of arrangements: $\frac{9!}{2!3!} = 30240$	B1	Accept unevaluated
	No with Ts together = $\frac{8!}{3!} = 6720$	B1	Accept unevaluated
	With Ts not together: $30\,240 - 6720$	M1	correct or $\frac{9!}{m} - \frac{8!}{n}$, m, n integers > 1 or <i>their</i> identified total – <i>their</i> identified Ts together
	23 520	A1	CAO
	Alternative method for question 7(ii)		
	$\frac{7!}{3!} \times \frac{8 \times 7}{2}$	B1	$7! \times (k > 0)$ in numerator, cannot be implied by ${}^7P_2$, etc.
		B1	$3! \times (k > 0)$ in denominator
		M1	$\frac{\text{their } 7!}{\text{their } 3!} \times {}^8C_2$ or ${}^8P_2$
	23 520	A1	CAO
		4	

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Question	Answer	Marks	Guidance
7(iii)	Number of arrangements = $\frac{7!}{3!}$ Probability = $\frac{\text{their } \frac{7!}{3!}}{\text{their } \frac{9!}{3!2!}} = \frac{840}{30240}$	M1	$\frac{\text{their identified number of arrangements with T at ends}}{\text{their identified total number of arrangements}}$ $\frac{7!}{9!}$ or $\frac{m}{n}$, m, n integers > 1
	$\frac{1}{36}$ or 0.0278	A1	Final answer
		2	
7(iv)	OOT__ ${}^4C_2 = 6$ OOTT_ ${}^4C_1 = 4$ OOOT_ ${}^4C_1 = 4$ OOOTT = 1	M1	${}^4C_x$ seen alone or ${}^4C_x \times k \geq 1$, k an integer, $0 < x < 4$
		A1	${}^4C_2 \times k$, $k = 1$ oe or ${}^4C_1 \times m$, $m = 1$ oe alone
		M1	Add 3 or 4 identified correct scenarios only, accept unsimplified
	(Total) = 15	A1	CAO, WWW Only dependent on 2nd M mark
		4	

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- 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**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

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Question	Answer	Marks	Guidance
1(i)	$\frac{120}{300} = 0.4$	B1	OE
		1	
1(ii)	$P(\text{male}) \times P(\text{not piano}) = \frac{160}{300} \times \frac{225}{300} \left(\frac{8}{15} \times \frac{3}{4} \right) = \frac{2}{5}$	M1	P(M) × P(P') seen Can be unsimplified but the events must be named in a product
	As $P(\text{male} \cap \text{not piano})$ also $= \frac{120}{300} = \frac{2}{5}$ The events are Independent	A1	Numerical comparison and correct conclusion
	Alternative method for question 1(ii)		
	$P(\text{male} \cap \text{not piano}) = \frac{120}{300}$; $P(\text{not piano}) = \frac{225}{300}$	M1	P(M P') or P(P' M) unsimplified seen with <i>their</i> probs with correctly named events
	$P(M \text{not piano}) = \frac{\frac{120}{300}}{\frac{225}{300}} = \frac{120}{225} = \frac{8}{15} = P(\text{male})$ or $P(\text{not piano} M) = \frac{\frac{120}{300}}{\frac{160}{300}} = \frac{120}{160} = \frac{3}{4} = P(\text{not piano})$ Therefore the events are Independent	A1	Numerical comparison with P(M) or P(P') and correct conclusion
		2	

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Question	Answer	Marks	Guidance
2(i)	$\frac{9!}{2!3!} = 30240$	B1	9! Divided by at least one of 2! or 3!
		B1	Exact value
		2	
2(ii)	D _____ R: $\frac{7!}{2!2!} = 1260$ D _____ O: $\frac{7!}{3!} = 840$	B1	7! Seen alone or as numerator in a term, can be multiplied not + or –
		B1	One term correct, unsimplified
	Total = 2100	B1	Final answer
		3	

Question	Answer	Marks	Guidance
3(i)	3A 2D 2M : ${}^6C_3 \times {}^5C_2 \times {}^4C_2 (= 1200)$ 4A 2D 1M : ${}^6C_4 \times {}^5C_2 \times {}^4C_1 (= 600)$ 3A 3D 1M : ${}^6C_3 \times {}^5C_3 \times {}^4C_1 (= 800)$	M1	${}^6C_x \times {}^5C_y \times {}^4C_z, x + y + z = 7$
		A1	2 correct products, allow unsimplified
		M1	Summing their totals for 3 correct scenarios only
	Total = 2600	A1	Correct answer SC1 ${}^6C_3 \times {}^5C_2 \times {}^4C_1 \times {}^9C_1 = 7200$
		4	

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Question	Answer	Marks	Guidance
3(ii)	${}^7C_4 \times 1$	B1	${}^7C_3$ or ${}^7C_4$ seen anywhere
	35	B1	
		2	

Question	Answer	Marks	Guidance
4(i)	$P(h < 148) = 0.67$	B1	$z = \pm 0.44$ seen
	$\frac{h - 148}{8} = 0.44$	M1	$z\text{-value} = \pm \frac{(h - 148)}{8}$
	$151.52 \approx 152$	A1	CAO
		3	
4(ii)	$P(144 < X < 152) = P\left(\frac{144 - 148}{8} < Z < \frac{152 - 148}{8}\right)$	M1	Using $\pm$ standardisation formula for either 144 or 152, $\mu = 148$, $\sigma = 8$ and no continuity correction, allow σ^2 or $\sqrt{\sigma}$
	$= P\left(-\frac{1}{2} < Z < \frac{1}{2}\right) = 0.6915 - (1 - 0.6915) = 2 \times 0.6915 - 1$	M1	Correct final area legitimately obtained from $\text{phi}(\text{their } z_2) - \text{phi}(\text{their } z_1)$
	$= 0.383$	A1	Final probability answer
	$0.383 \times 120 = 45.96$ Accept 45 or 46 only	B1FT	Their prob (to 3 or 4 sf) $\times 120$, rounded to a whole number or truncated
		4	

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Question	Answer	Marks	Guidance
5(i)	Correct labels and scales	B1	Axes labelled ‘cumulative frequency’ (or cf) and ‘time (or t) [in] min(utes)’, linear scales from 0 to 90 and 0 to 200 with at least 3 values marked on each axis.
	7 correctly plotted points above upper boundaries joined in a curve or line segments	B1	(0, 0); (10, 16); (20, 50); (30, 106); (50, 146); (70, 176); (90, 200)
		2	
5(ii)	29	B1	$28 \leq \text{median} \leq 30$
		1	
5(iii)	120 seen	M1	For seeing 120 in a calculation or marked on the graph
	37	A1FT	$36 \leq \text{Ans} \leq 39$ or FT from <i>their</i> graph SC1 unsupported answer in range
		2	
5(iv)	Frequencies 16 34 56 40 30 24	B1	Seen. Allow unsimplified
	Est. Mean = $\frac{5 \times 16 + 15 \times 34 + 25 \times 56 + 40 \times 40 + 60 \times 30 + 80 \times 24}{200}$	M1	At least 4 correct midpoints (5, 15, 25, 40, 60, 80) used in a calculation
	$\frac{7310}{200}$	M1	Summing products of <i>their</i> 6 mid-points (not lower or upper bound or class width) $\times$ <i>their</i> frequencies / 200 (or <i>their</i> Σf), unsimplified
	36.55	A1	Accept 36.6
		4	

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Question	Answer	Marks	Guidance
6(i)	$P(RR) = \frac{3}{8} \times \frac{2}{7} = \frac{3}{28}$	B1	OE
		1	
6(ii)	$P(RW) + P(WR)$ $\frac{3}{8} \times \frac{5}{7} + \frac{5}{8} \times \frac{3}{7}$	M1	Method shown, numerical calculations identified, may include replacements
	$= \frac{15}{28}$	A1	AG, Fully correct calculations
	Alternative method for question 6(ii)		
	$1 - (P(RR) + P(WW))$ $1 - \left(\frac{3}{28} + \frac{5}{8} \times \frac{4}{7} \right)$	M1	Method shown, numerical calculations identified, may include replacements
	$= \frac{15}{28}$	A1	AG, Fully correct calculations
		2	
6(iii)	$P(\text{first red} \text{second red}) = \frac{\text{their (i)}}{\text{their (i)} + \frac{5}{8} \times \frac{3}{7}} = \frac{\frac{3}{8} \times \frac{2}{7}}{\frac{3}{8} \times \frac{2}{7} + \frac{5}{8} \times \frac{3}{7}} = \frac{\frac{3}{28}}{\frac{21}{56}}$	M1	Conditional probability formula used consistent with <i>their</i> probabilities or correct
	$= \frac{2}{7}$	A1	OE
		2	

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Question	Answer				Marks	Guidance								
6(iv)	<table border="1"><tr><td>x</td><td>0</td><td>1</td><td>2</td></tr><tr><td>p</td><td>$\frac{10}{28}$</td><td>$\frac{15}{28}$</td><td>$\frac{3}{28}$</td></tr></table>				x	0	1	2	p	$\frac{10}{28}$	$\frac{15}{28}$	$\frac{3}{28}$	B1	Probability distribution table with correct values of x and at least one correct probability placed. Extra x values allowed with probability of zero stated.
	x	0	1	2										
	p	$\frac{10}{28}$	$\frac{15}{28}$	$\frac{3}{28}$										
				B1FT	Fully correct FT $P(2) = \textit{their (i)}$, $P(1) = \textit{their (ii)}$, $\Sigma(p) = 1$.									
				2										
6(v)	$E(X) = \frac{30}{56} + \frac{12}{56} = \frac{42}{56} \quad \left(= \frac{3}{4} \right)$				B1	May be implied by use in variance formula								
	$Var(X) = \frac{30}{56} + \frac{24}{56} - \left(\textit{their} \frac{3}{4} \right)^2$				M1	Substitute into correct variance formula, must have ‘ $ - \textit{their mean}^2$ ’, Must be for 2 or more non-zero x -values								
	$\frac{45}{112}$ or 0.402				A1	Correct final answer								
					3									

Question	Answer	Marks	Guidance
7(i)(a)	$P(0, 1, 2) = {}^6C_0 0.3^0 0.7^6 + {}^6C_1 0.3^1 0.7^5 + {}^6C_2 0.3^2 0.7^4$	M1	Binomial term of form ${}^6C_x p^x (1-p)^{6-x}$ $0 < p < 1$ any $p, x \neq 6, 0$
	0.1176 ... + 0.3025 ... + 0.3241 ...	A1	Correct unsimplified answer
	0.744	A1	Correct final answer
		3	

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Question	Answer	Marks	Guidance
7(i)(b)	$P(\text{support neither choir}) = 1 - (0.3 + 0.45) = 0.25$	M1	0.25^n seen alone, $1 < n \leq 6$
	$P(6 \text{ support neither choir}) = 0.25^6$ $= 0.000244$ or $\frac{1}{4096}$	A1	Correct final answer
		2	
7(ii)	Mean = $240 \times 0.25 = 60$ Variance = $240 \times 0.25 \times 0.75 = 45$	B1FT	Correct unsimplified $240p$ and $240pq$ where $p = \text{their } P(\text{support neither choir})$ or 0.25
	$P(X < 50) = P\left(Z < \frac{49.5 - 60}{\sqrt{45}}\right) = P(Z < -1.565)$	M1	Substituting <i>their</i> μ and σ (condone σ^2) into the $\pm$ Standardisation Formula with a numerical value for '49.5'.
		M1	Using continuity correction 49.5 or 50.5 within a standardisation expression
	$1 - 0.9412$	M1	Appropriate area Φ from standardisation formula $P(z < \dots)$ in final solution, (< 0.5 if z is $-ve$, > 0.5 if z is $+ve$)
	0.0588	A1	Correct final answer
		5	