Question	Answer	Marks	Guidance
1	**Method 1**		
	... M … M … M … M … M …	**M1**	k × 5! (120) or k × 6P2 (30), k is an integer ⩾ 1,
	No. ways men placed × No. ways women placed in gaps = 5! × $^6P_2$	**M1**	Correct unsimplified expression
	= 3600	**A1**	Correct answer
	Method 2		
	Number with women together = 6! × 2 (1440) Total number of arrangements = 7! (5040)	**M1**	6! × 2 or 7! – k seen, k is an integer ⩾ 1
	Number with women not together = 7! – 6! × 2	**M1**	Correct unsimplified expression
	= 3600	**A1**	Correct answer
		3	

Question	Answer	Marks	Guidance
2(i)	x | −2 | −1 | 0 | 1 | 2 | 3 P($X = x$) | $\frac{2}{18}$ | $\frac{4}{18}$ | $\frac{5}{18}$ | $\frac{4}{18}$ | $\frac{2}{18}$ | $\frac{1}{18}$	**B1**	–2, –1, 0, 1, 2, 3 seen as top line of a pdf table OR attempting to evaluate P(–2), P(–1), P(0), P(1), P(2), P(3),
		B1	At least 4 probs correct (need not be in table)
		B1	All probs correct in a table
		3	

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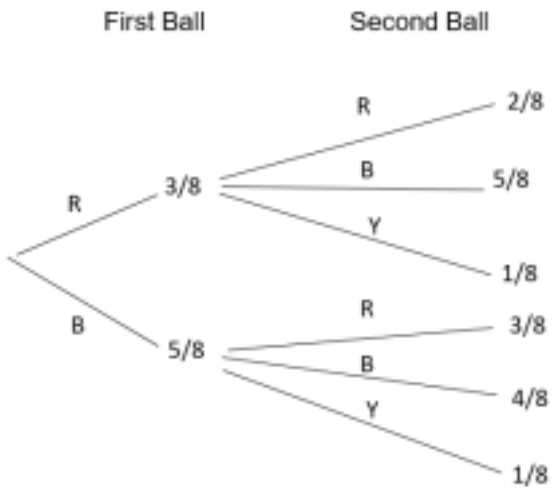
Question	Answer	Marks	Guidance
2(ii)	$E(X) = \frac{-4-4+0+4+4+4+3}{18} = \frac{1}{6}$	**M1**	Correct unsimplified expression for the mean using their table, $\Sigma p = 1$, may be implied
	$Var(X) = \frac{8+4+0+4+8+8+9}{18} - \left(\frac{1}{6}\right)^2$ $=11/6 - 1/36\ (1.8333 - 0.02778)$	**M1**	Correct, unsimplified expression for the variance using their table, and their mean^2 subtracted. Allow $\Sigma p \neq 1$
	$= 65/36,\ (1.81)$	**A1**	Correct answer
		3	

Question	Answer	Marks	Guidance
3(i)		**B1**	Fully correct labelled tree and correct probabilities for 'First Ball'
		B1	Correct probabilities (with corresponding labels) for 'Second Ball'
		2	
3(ii)	P(RR) + P(BB) = 3/8 × 2/8 + 5/8 × 4/8 = 3/32 + 5/16	**M1**	Correct unsimplified expression from their tree diagram, Σp = 1 on each branch
	= 13/32 (0.406)	**A1**	Correct answer
		2	

Question	Answer	Marks	Guidance
3(iii)	P(RB) = 3 / 8 × 5 / 8 = 15/64	M1	$P(\text{1st ball red}) \times P(\text{2nd ball blue})$ from their tree diagram seen unsimplified as numerator or denominator of a fraction Allow $\Sigma p \neq 1$ on each branch
	P(B) = 3/8 × 5/8 + 5/8 × 4/8 = 35/64	M1	Correct unsimplified expression for P(B) from their tree diagram seen as denominator of a fraction. Allow $\Sigma p \neq 1$ on each branch
	P(R|B) = P(RB) / P(B) = (15/64) ÷ (35/64) = 3/7 (0.429)	A1	Correct answer
		3	

Question	Answer	Marks	Guidance
4(i)	Total number of selections = $^{12}C_7 = 792$	B1	Seen as denominator of fraction
	Selections with boy included = $^{11}C_6$ or $^{12}C_7 - {}^{11}C_7 = 462$	M1	Correct unsimplified expression for selections with boy included seen as numerator of fraction
	Probability = 462/792 = 7/12 (0.583)	A1	Correct answer
	OR		
	prob of boy not included = 11/12 × 10/11 × …. × 5/6= 5/12	B1	Correct unsimplified prob
	1 – 5/12	M1	Subtracting prob from 1
	= 7/12	A1	Correct answer
		3	

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Question	Answer	Marks	Guidance
4(ii)	**Method 1**		
	Scenarios are: 2G + 5B: $^4C_2 \times {}^8C_5 = 336$	**B1**	One unsimplified product correct
	3G + 4B: $^4C_3 \times {}^8C_4 = 280$ 4G + 3B: $^4C_4 \times {}^8C_3 = 56$	**M1**	No of selections (products of ^nC_r and ^nP_r) added for 2, 3 and 4 girls with no of girls and no of boys summing to 7
	Total = 672	**A1**	Correct total
	Probability = 672/792 (28/33) (0.848)	**A1ft**	Correct answer – 'total'/('total no of selections' from i)
	Method 2		
	0G + 7B $^4C_0 \times {}^8C_7 = 8$	**B1**	One unsimplified no of selections correct
	1G + 6B $^4C_1 \times {}^8C_6 = 112$ Total = 8 + 112 = 120	**M1**	No of selections (products of ^nC_r and ^nP_r) added for 0 and 1 girls with no of girls and no of boys summing to 7
	$(^{12}C_7 - 120)/792$ or $1 - 120/792$	**A1**	792 – 120 = 672 or 1 – 120/792
	Probability = 672/792 (28/33) (0.848)	**A1ft**	'672' over '792' from i
	Method 3 (probability)		
	1 – P(0) – P(1) = 1 – (8/12 × 7/11 × …… × 2/6) – (8/12 × … × 3/7 × 4/6 × 7)	**B1**	One correct unsimplified prob for 0 or 1
	= 1 – 1/99 –14/99	**M1**	Subtracting 'P(0)' and 'P(1)' (using products of 7 fractions with denominators from 12 to 6) from 1
		A1	Both probs correct unsimplified
	= 84/99 = 28/33	**A1ft**	1 – 'P(0)' – 'P(1)'

Question	Answer	Marks	Guidance
4(ii)	**Method 4 (probability)**		
	P(2) + P(3) + P(4) =	**B1**	One correct unsimplified prob for 2, 3 or 4
	42/99 + 35/99 + 7/99	**M1**	Adding 'P(2)', 'P(3)' and P(4)' (using products of 7 fractions with denominators from 12 to 6)
		A1	Three probs correct unsimplified
	= 84/99 = 28/33	**A1ft**	'P(2)'+ 'P(3)' + 'P(4)'
		4	

Question	Answer	Marks	Guidance
5(i)	$z_1 = \pm\frac{90-120}{24} = -\frac{5}{4}$, $z_2 = \pm\frac{140-120}{24} = \frac{5}{6}$	**M1**	At least one standardisation, no cc, no sq rt, no sq using 120 and 24 and either 90 or 140
	$= \Phi\left(\frac{20}{24}\right) - \Phi\left(-\frac{30}{24}\right)$	**A1**	–5/4 and 5/6 unsimplified
	$= \Phi(0.8333) - (1 - \Phi(1.25))$ = 0.7975 – (1 – 0.8944) or 0.8944 – 0.2025 = 0.6919	**M1**	Correct area Φ – Φ legitimately obtained and evaluated from phi(their z_2) – phi (their z_1)
	= 0.692 AG	**A1**	Correct answer obtained from 0.7975 and 0.1056 oe to 4sf or 0.6919 seen www
		4	

Question	Answer	Marks	Guidance
5(ii)	**Method 1**		
	Probability = P(2, 3, 4) $= 0.692^2(1-0.692)^2 \times {}^4C_2 + 0.692^3(1-0.692) \times {}^4C_3 + 0.692^4$	**M1**	Any binomial term of form $4C_x p^x (1-p)^{4-x}$, $x \neq 0$ or 4
		B1	One correct bin term with $n = 4$ and $p = 0.692$,
	$= 0.27256 + 0.40825 + 0.22931$	**M1**	Correct unsimplified expression using 0.692 or better
	$= 0.910$	**A1**	Correct answer
	Method 2:		
	$1 - P(0, 1) =$	**M1**	Any binomial term of form $4C_x p^x (1-p)^{4-x}$, $x \neq 0$ or 4
	$1 - 0.692^0(1-0.692)^4 \times {}^4C_0 - 0.692^1(1-0.692)^3 \times {}^4C_1$	**B1**	One correct bin term with $n = 4$ and $p = 0.692$
	$= 1 - 0.00899 - 0.0808757$	**M1**	Correct unsimplified expression using 0.692 or better
	$= 0.910$	**A1**	Correct answer
		4	

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Question	Answer	Marks	Guidance
6(i)	$P(X>1800) = 0.96$, so $P(Z > \frac{1800-2000}{\sigma}) = 0.96$	**B1**	± 1.75 seen
	$\Phi(\frac{200}{\sigma}) = 0.96$ $\frac{200}{\sigma} = 1.751$	**M1**	$z = \pm\frac{1800-2000}{\sigma}$, allow cc, allow sq rt, allow sq equated to a z-value
	$\sigma = 114$	**A1**	Correct final answer www
		3	
6(ii)	Mean = 300 × 0.2 = 60 and variance = 300 × 0.2 × 0.8 = 48	**B1**	Correct unsimplified mean and variance
	$P(X < 70) = P(Z > \frac{69.5-60}{\sqrt{48}})$	**M1**	$Z = \pm\frac{x - their\,60}{\sqrt{their\,48}}$
	$= \Phi(1.371)$	**M1**	69.5 or 70.5 seen in an attempted standardisation expression as cc
	=0.915	**A1**	Correct final answer
		4	
6(iii)	*np* = 60, *nq* = 240: both > 5, (so normal approximation holds)	**B1**	Both parts evaluated are required
		1	

Question	Answer	Marks	Guidance
7(i)	Anvils | Brecons 8 | 15 9 5 | 16 | 6 5 3 2 0 | 17 | 0 1 2 2 8 4 1 0 | 18 | 1 2 3 3 6 | 19 | 2 Key: 5|16|6 means 165 cm for Anvils and 166 cm for Brecons	**B1**	Correct stem, up or down
		B1	Correct Anvils labelled on left, leaves in order from right to left and lined up vertically, no commas
		B1	Correct Brecons labelled on same diagram on right hand side in order from left to right and lined up vertically, no commas
		B1	Correct key, not split, both teams, at least one with cm
		4	
7(ii)	Median = 173	**B1**	Correct median (or Q2)
	LQ = 169; UQ = 181 IQR = 181 – 169	**M1**	Either UQ = 181 ± 4, or LQ = 169 ± 4 and evaluating UQ – LQ
	= 12	**A1**	Correct answer from 181 and 169 only
		3	

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Question	Answer	Marks	Guidance
7(iii)	$\Sigma x = 1923 + 166 + 172 + 182$ (= 2443) $\sum x^2 = 337221 + 166^2 + 172^2 + 182^2$ (= 427485)	**M1**	Correct unsimplified expression for $\sum x$ and $\sum x^2$, may be implied
	Mean = $\frac{\sum x}{14} = \frac{2443}{14} = 174.5$	**M1**	Correct unsimplified mean
	Variance = $\frac{\sum x^2}{14} - \left(\frac{\sum x}{14}\right)^2 = \frac{427485}{14} - \left(\frac{2443}{14}\right)^2$	**M1**	Correct unsimplified variance using 14, their Σx and their Σx^2, not using 1923 and/or 337221
	S d = 9.19	**A1**	Correct answer
		4	

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