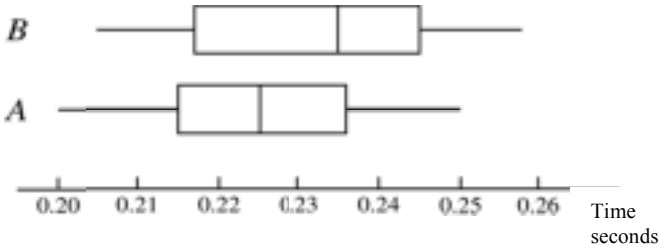
Question	Answer	Marks	Guidance
1(i)	$\frac{11!}{4!4!2!}$	**M1**	$\frac{11!}{4!\times k}$ *or* $\frac{11!}{2!\times k}$, k a positive integer
	= 34650	**A1**	Correct final answer
		2	
1(ii)	**Method 1**		
	P(SS) = $\frac{4}{11}\times\frac{3}{10}=\frac{12}{110}$ (= 0.10911)	**B1**	One of P(SS), P(PP) or P(II) correct, allow unsimplified
	P(PP) = $\frac{2}{11}\times\frac{1}{10}=\frac{2}{110}$ (= 0.01818) P(II) = $\frac{4}{11}\times\frac{3}{10}=\frac{12}{110}$ (= 0.10911) $\frac{4}{11}\times\frac{3}{10}$	**M1**	Sum of probabilities from 3 appropriate identifiable scenarios (either by labelling or of form $\frac{4}{11}\times\frac{a}{b}+\frac{2}{11}\times\frac{c}{b}+\frac{4}{11}\times\frac{a}{b}$ where a = 4 *or* 3, b = 11 *or* 10, c = 2 *or* 1)
	Total = $\frac{26}{110}=\frac{13}{55}$ oe (0.236)	**A1**	Correct final answer
	Method 2		
	Total number of selections = $^{11}C_2$ = 55 Selections with 2 Ps = 1	**B1**	Seen as the denominator of fraction (no extra terms) allow unsimplified
	Selections with 2 Ss = $^4C_2$ = 6 Selections with 2 Is = $^4C_2$ = 6,	**M1**	Sum of 3 appropriate identifiable scenarios (either by labelling or values, condone use of permutations. May be implied by 2,12,12)
	Total selections with 2 letters the same = 13 Probability of 2 letters the same = $\frac{13}{55}$ oe (0.236)	**A1**	Correct final answer, without use of permutations
		3	

Question	Answer	Marks	Guidance
2(i)	median = 0.225; LQ = 0.215: UQ = 0.236	**B1**	Correct median (Q_2)
	IQR = 0.236 – 0.215	**M1**	0.232 < UQ (Q_3) < 0.238 – 0.204 < LQ (Q_1) < 0.219
	= 0.021	**A1**	www Omission of all decimal points **MR-1** If M0 awarded **SCB1** for both LQ = 0.215: UQ = 0.236 seen
		3	
2(ii)		**B1**	Linear scale between 0.20 to 0.26 (condone omission of 0.26) axis labelled (time and seconds), at least one box plot attempted, no lines through boxes, whiskers not at corner of boxes
		B1 ft	Labelled correct graph for A, (ft their median/quartiles), condone lines through boxes, whiskers at corner of boxes
	A 0.200 0.215 0.225 0.236 0.250 **B** 0.205 0.217 0.235 0.245 0.258	**B1**	Labelled correct graph for B, condone lines through boxes, whiskers at corner of boxes **SC** If B0B0 scored because graphs not labelled/labels reversed SCB1 if both 'correct' Penalty **MR-1** if graphs plotted on separate axes unless both scales align exactly.
		3	

Question	Answer	Marks	Guidance
3(i)	**Method 1**		
	$P(3) + P(4) + P(5) = {}^5C_3\ 0.75^3 \times 0.25^2\ +$	**M1**	One binomial term ${}^5C_x p^x(1-p)^{5-x}$, $x \neq 0$ or 5, any p
	${}^5C_4\ 0.75^4 \times 0.25^1\ + {}^5C_5\ 0.75^5 \times 0.25^0$	**M1**	Correct unsimplified expression
	$= 0.26367 + 0.39551 + 0.23730$ $= 0.896\ \ (459/512)$	**A1**	Correct final answer, allow 0.8965 (isw) but not 0.897 alone
	Method 2		
	$1 - P(0) - P(1) - P(2) = 1 - {}^5C_0\ 0.75^0 \times 0.25^5$	**M1**	One binomial term ${}^5C_x p^x(1-p)^{5-x}$, $x \neq 0$ or 5, any p
	$- {}^5C_1\ 0.75^1 \times 0.25^4 - {}^5C_2\ 0.75^2 \times 0.25^3$	**M1**	Correct simplified expression
	$= 1 - 0.00097656 - 0.014648 - 0.087891$ $= 0.896\ (459/512)$	**A1**	Correct final answer, allow 0.8965 (isw) but not 0.897 alone
		3	

Question	Answer	Marks	Guidance
3(ii)	**Method 1**		
	P(C,C) + P(C,C′) + P(C′,C) 0.8 × 0.9	**B1**	Unsimplified prob completed on both days
	0.8 × 0.1 + 0.2 × 0.6	**M1**	Unsimplified prob 0.8 × *a* + 0.2 × *b*, *a* = 0.1or 0.4, *b* = 0.6 or 0.9
	= 0.92 oe	**A1**	Correct final answer
	Method 2		
	1 – P(C′,C′) = 1 – 0.2 × 0.4	**B1**	Unsimplified prob completed on no days
		M1	1 – 0.2 × *a*, *a*=0.1or 0.4 allow unsimplified
	= 0.92	**A1**	Correct final answer
		3	

Question	Answer	Marks	Guidance
4(i)	5! × 6! ×2	**B1**	k×5! or *m*×6! (*k,m* integer, *k,m* ⩾ 1), no inappropriate addition
		B1	*n* × 5! × 6! (*n* integer, *n* ⩾ 1), no inappropriate addition
	= 172800	**B1**	Correct final answer, isw rounding (www scores B3) All marks based on their **final** answer
		3	

Question	Answer	Marks	Guidance
4(ii)	… G … G … G … G … G … G … No. ways girls placed × No. ways boys placed in gaps =	**M1**	$k \times 6!$ or $k \times {}^7P_5$ (k is an integer, $k \geqslant 1$) no inappropriate add. (${}^7P_5 \equiv 7 \times 6 \times 5 \times 4 \times 3$ or ${}^7C_5 \times 5!$)
	$6! \times {}^7P_5$	**M1**	Correct unsimplified expression
	$= 1814400$	**A1**	Correct exact final answer (ignore subsequent rounding)
		3	

Question	Answer	Marks	Guidance
5(i)	$\dfrac{15.5 \times 12 + 910}{12 + 20}$	**M1**	Unsimplified total age divided by *their* total members (not 12, 20 or 2)
	=34.25 or 34¼ (years)	**A1**	Correct exact answer (isw rounding), oe (34 years 3 months)
		2	
5(ii)	Considering Juniors: variance = $\dfrac{\sum x^2}{12} - 15.5^2 = 1.2^2$	**M1**	$\dfrac{\sum x^2}{k} - 15.5^2 = 1.2^2$, $k = 12$ or 20
	$\sum x^2 = 2900.28$	**A1**	Answer wrt 2900
	Considering whole group: $\sum z^2 = \sum x^2 + \sum y^2 = 2900.28 + 42850 = 45750$ Variance = $\dfrac{\sum z^2}{32} - \mu^2 = \dfrac{\textit{their}\ 45750}{12 + 20} - (\textit{their}\ 34.25)^2$ (= 256.63)	**M1**	*Their* 45750 > 42850 (not 85700 or rounding to 1.8×10^9) in correct variance or std deviation formula (Σx^2 and addition may not be seen)
	s d = 16.0(2)	**A1**	Correct final answer, condone 16.03
		4	

Question	Answer	Marks	Guidance
6(i)	x: –2, –1, 0, 1, 2, 3 p: $\frac{1}{12}$, $\frac{2}{12}$, $\frac{3}{12}$, $\frac{3}{12}$, $\frac{2}{12}$, $\frac{1}{12}$	**B1**	–2, –1, 0, 1, 2, 3 seen as top line of a pdf table with at least 1 probability OR attempting to evaluate P(–2), P(–1), P(0), P(1), P(2), P(3) (condone additional values with p=0 stated)
		B1	At least 4 probs correct (need not be in table)
		B1	All probs correct in a table
		3	
6(ii)	$\mathrm{E}(X) = \frac{-2\times1-1\times2+0+1\times3+2\times2+1\times3}{12} = 0.5$	**M1**	Unsimplified expression for mean using *their* pdf table (or correct) with at least 2 non-zero values (may be seen in variance). Numerator terms may be implied by values.
	$\mathrm{Var}(X) = \frac{(-2)^2\times1+(-1)^2\times2+1^2\times3+2^2\times2+3^2\times1}{12} - (\textit{their}\ 0.5)^2$	**M1**	Unsimplified expression for variance using *their* pdf table (or correct) with at least 2 non-zero values and *their* E(X). Numerator terms may be implied by values. If $-k^2$ is seen for $(-k)^2$, the method must be confirmed by seeing value used correctly
	26/12 −1/4 = 23/12	**A1**	Correct final answer
		3	

Question	Answer	Marks	Guidance
6(iii)	**Method 1**		
	P(X non-zero) = 9/12	**B1ft**	If Binomial distribution used 0/3 P(X non-zero) ft from *their* pdf table, Σp=1 oe
	$P(X = 1 \mid X \text{ non-zero}) = \frac{P(X = 1 \cap X \text{ non-zero})}{P(X \text{ non-zero})} = \frac{3/12}{9/12}$	**M1**	*Their* P(X = 1)/*their* P(X non-zero) from *their* pdf table oe
	= 1/3 oe	**A1**	Correct final answer www
	Method 2		
	$P(X = 1 \mid X \text{ non-zero}) = \frac{\text{Number of outcomes} = 1}{\text{Number of non-zero outcomes}}$	**B1ft**	Number of non-zero outcomes (expect 9) ft from *their* outcome table or pdf table numerators oe
		M1	*a/b, a = their* 3 from *their* outcome table or pdf table numerators, *b = their* 9 (not 12)
	$= \frac{3}{9} = \frac{1}{3}$ oe	**A1**	Correct final answer www
		3	

Question	Answer	Marks	Guidance
7(a)(i)	$P(X < 4) = P\left(Z < \frac{4 - 3.24}{0.96}\right)$	**M1**	±Standardisation formula, no cc, no sq rt, no square
	$= P\left(Z < 0.7917\right) = 0.7858$	**A1**	$0.7855 < p \leqslant 0.7858$ or p = 0.786 Cao (implies M1A1 awarded), may be seen used in calculation
	their 0.7858 × 365 = 286 (or 287)	**B1ft**	*Their* probability × 365 provided 4sf probability **seen**. FT answer rounded or truncated to nearest integer. No approximation notation used.
		3	
7(a)(ii)	$P(X < k) = P(Z < \frac{k - 3.24}{0.96}) = 0.8$	**B1**	(z=) ± 0.842 seen
	$\frac{k - 3.24}{0.96} = 0.842$	**M1**	$z = \pm\frac{k - 3.24}{0.96}$, allow cc, sq rt or square equated to a *z*-value (0.7881, 0.2119, 0.158, 0.8, 0.2 etc. are not acceptable)
	$k = 4.05$	**A1**	Correct final answer, www
		3	
7(a)(iii)	$P(-1.5 < Z < 1.5) =$	**M1**	$\Phi(z = 1.5)$ or $\Phi(z = -1.5)$ seen used or $p = 0.9332$ seen
	$\Phi(1.5) - \Phi(-1.5) = 2\Phi(1.5) - 1$ = 2 × 0.9332 – 1 oe	**M1**	Correct final area expression using *their* probabilities
	= 0.866	**A1**	Correct final answer
		3	

Question	Answer	Marks	Guidance
7(b)	$P(Y > 0) = P\left(Z > \frac{0-\mu}{\sigma}\right) \equiv P\left(Z > \frac{0-\mu}{3\mu/4}\right)$ or $P\left(Z > \frac{0-\left(\frac{4\sigma}{3}\right)}{\sigma}\right)$	**M1**	±Standardisation attempt in terms of one variable no sq rt or square, condone ±0.5 as cc
	$= P(Z > -4/3)$	**A1**	Correct unsimplified standardisation, no variables
	$= 0.909$	**A1**	Correct final answer
		3	

Alternative methods for Question 1(ii)

Method 3

$P(S,S') = \frac{4}{11} \times \frac{7}{10} = \frac{28}{110}$

$P(P,P') = \frac{2}{11} \times \frac{9}{10} = \frac{18}{110}$

$P(I,I') = \frac{4}{11} \times \frac{7}{10} = \frac{28}{110}$

$P(M,M') = \frac{1}{11} \times \frac{10}{10} = \frac{10}{110}$

$Total = \frac{84}{110}$

$P(Same) = 1 - \frac{84}{110} = \frac{26}{110}$

B1 one of products correct
M1 1 – sum of probabilities from 4 appropriate scenarios
A1 Correct final answer

Method 4

PP' = $\frac{2\times9}{2} = 9$

SS' = $\frac{4\times7}{2} = 14$

II' = $\frac{4\times7}{2} = 14$

MM' = $\frac{1\times10}{2} = 5$

Total number of ways = $\frac{10\times11}{2} = 55$

Number of ways of letters repeating = 55 – (9 + 14 + 14 + 5) = 13

P(Same) = $\frac{13}{55}$

B1 $^{11}C_2$ seen as the denominator of fraction (no extra terms) allow unsimplified
M1 1 – sum of 4 appropriate scenarios
A1 Correct final answer