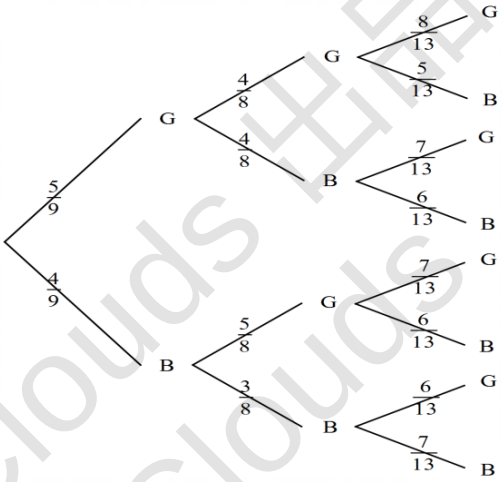
Question	Scheme	Marks
1. (a)	Width = $\frac{5}{3}\times 1.5$ = **<u>2.5 (cm)</u>**	B1
	Area = $6\times 1.5 = 9$ cm^2 has frequency = 12 so 1.5 cm^2 = 2 people (o.e.)	M1
	Frequency of 10 corresponds to area of 7.5 so height = **<u>3 (cm)</u>**	A1 (3)
(b)	$Q_2 = [2.5+]\frac{(25/25.5-16)}{12}\times 3 = 4.75$ (or 4.875 if use $n+1$) awrt **<u>4.75</u>**	M1 A1 (2)
(c)(i)	$[\overline{x} =]\ \frac{394}{50} = 7.88$ **(*)**	B1cso
(ii)	$[\sigma_x =]\ \sqrt{\frac{6500}{50}-\overline{x}^2} = \sqrt{67.9056}$	M1A1
	= **<u>awrt 8.24</u>** (Accept s = awrt 8.32)	A1 (4)
(d)	$\overline{x} > Q_2$	B1ft
	So <u>positive</u> (skew)	dB1 (2)
(e) (i)	There is <u>no effect</u> on the mean	B1
(ii)	The median will <u>increase</u>	B1
(iii)	The standard deviation will <u>decrease</u>	B1 (3)
		[14]

	Notes
(a)	M1 for forming a relationship between area and no. of people <u>or</u> "their width" × "their height"= 7.5 <u>or</u> for $\frac{3h}{10}=\frac{9}{12}$ oe A1 for height of 3 (cm) NOTE: the common incorrect answer width = 3 and height = 2.5 scores B0M1A0
(b)	M1 for a correct fraction$\left[\frac{9}{12}\right.$ or $\left.\frac{9.5}{12}\right]\times 3$. Ignore end point but must be +. May be seen in an equivalent expression e.g. $\frac{(x-2.5)}{5.5-2.5}=\frac{25-16}{28-16}$ Allow use of (n + 1) giving 4.875 NB May work down so look out for $[5.5]-\frac{28-25}{12}\times 3$, etc.
(c)(i)	B1 for $\frac{394}{50}$ or for fully correct expression seen $\frac{16\times 1.25+12\times 4+10\times 8+8\times 15.5+4\times 30.5}{50}$
(ii)	M1 for a correct expression must have 6500, 50 and 7.88. (square root not necessary for M1) 1st A1 for a correct expression which must have square root 2nd A1 for awrt 8.24 (use of s = awrt 8.32). Condone incorrect labelling if awrt 8.24 is found.
(d)	1st B1ft for a correct comparison of $\overline{x}$ =7.88 and their Q_2 (this may be seen embedded in another formula i.e. 3(mean-median)/s.d.) $Q_3-Q_2 > Q_2-Q_1$ is B0 unless Q_1 and Q_3 have been found. (Q_1 = 1.95/1.99 , Q_3 = 10.25/10.81) 2nd dB1 Dependent on the 1st B1 and for concluding "positive" skew. Note: if their Q_2 >7.88, then B0. Positive correlation is B0.

Question	Scheme		Marks
2 (a)		$\frac{5}{8}$ & $\frac{3}{8}$ $\frac{8}{13}$ & $\frac{5}{13}$ $\frac{7}{13}$ & $\frac{6}{13}$	B1 B1 B1
			(3)
(b)	$\frac{5}{9}\times\frac{4}{8}+\frac{4}{9}\times'\frac{5}{8}'=\frac{5}{9}$ oe		M1 A1
			(2)
(c)	$\frac{5}{9}\times\frac{4}{8}\times'\frac{8}{13}'+\frac{4}{9}\times'\frac{3}{8}'\times\frac{7}{13}=\frac{61}{234}$ oe		M1 A1
			(2)
(d)	$\frac{\frac{5}{9}\times\frac{4}{8}\times'\frac{8}{13}'}{'\frac{61}{234}'}\left[=\frac{\frac{20}{117}}{\frac{61}{234}}\right]=\frac{40}{61}$ oe		M1 A1ft A1
			(3)
	Notes		**Total 10**
(a)	**B1**	for $\frac{5}{8}$ & $\frac{3}{8}$ in the correct place on the 2nd branches Allow 0.625 & 0.375 or 62.5% & 37.5%	
	B1	for $\frac{8}{13}$ & $\frac{5}{13}$ in the correct place on the 3rd branches Allow awrt 0.615 & awrt 0.385 or awrt 61.5% & awrt 38.5%	
	B1	for $\frac{7}{13}$ & $\frac{6}{13}$ in both correct places on the 3rd branches Allow awrt 0.538 & awrt 0.462 or awrt 53.8% or awrt 46.2%	
(b)	**M1**	for $\frac{5}{9}\times\frac{4}{8}+\frac{4}{9}\times'\frac{5}{8}'$ ft their tree diagram provided these are probabilities Allow $\frac{5}{9}\times\frac{4}{8}\times'\frac{7}{13}'+\frac{5}{9}\times\frac{4}{8}\times'\frac{6}{13}'+\frac{4}{9}\times'\frac{5}{8}'\times'\frac{7}{13}'+\frac{4}{9}\times'\frac{5}{8}'\times'\frac{6}{13}'$	
	A1	$\frac{5}{9}$ oe Allow awrt 0.556 or awrt 55.6%	
(c)	**M1**	for $\frac{5}{9}\times\frac{4}{8}\times'\frac{8}{13}'+\frac{4}{9}\times'\frac{3}{8}'\times\frac{7}{13}$ ft their tree diagram provided these are probabilities	
	A1	$\frac{61}{234}$ oe Allow awrt 0.261 or awrt 26.1%	
(d)	**M1**	for $\frac{\text{a probability}}{\text{part (c)}}$ where numerator < denominator and 0 < part (c) < 1	
	A1ft	for finding the correct numerator Allow awrt 0.171 or awrt 17.1% or ft their tree diagram If the answer is incorrect then working must be shown	
	A1	$\frac{40}{61}$ oe Allow awrt 0.656 or awrt 65.6%	

Question Number	Scheme	Marks
3. (a)	$P(X=3) = F(3) - F(2) = \frac{1}{38}$	M1
	$P(X=3) = \frac{7}{n} \times \frac{6}{n-1} \times \frac{5}{n-2}$	M1
	$\frac{7}{n} \times \frac{6}{n-1} \times \frac{5}{n-2} = \frac{1}{38} \rightarrow n(n-1)(n-2) = 7980$ (*)	M1 A1cso
		(4)
(b)	$21 \times 20 \times 19 = 7980$	B1cso
		(1)
(c)	$a = F(0) = P(X=0) = \frac{14}{21} \times \frac{13}{20} \times \frac{12}{19}$	M1
	$a = \frac{26}{95}$	A1
	$P(X=1)\ \ 3 \times \frac{14}{21} \times \frac{13}{20} \times \frac{7}{19} \left[= \frac{91}{190} \right]$ **or** $P(X=2)\ \ 3 \times \frac{7}{21} \times \frac{6}{20} \times \frac{14}{19} \left[= \frac{21}{95} \right]$	M1 M1
	$b = F(1) = P(X=0) + P(X=1) = "\frac{26}{95}" + "\frac{91}{190}"$ or $b = \frac{37}{38} - "\frac{21}{95}"$	dM1
	$b = \frac{143}{190}$	A1
		(6)
		[11]

	Notes
(a)	1st M1 for use of F(3) – F(2) Accept $\frac{1}{38}$ 2nd M1 product of 3 probabilities where the denominators are n, $(n-1)$ and $(n-2)$ and the numerators are decreasing k, $(k-1)$ and $(k-2)$ This may be seen as a single term in a longer expression. 3rd M1 setting up equation for $P(X=3)$ = product of correct 3 probabilities without replacement A1cso fully correct solution with no errors seen
(b)	B1cso correctly evaluated product. Allow $21(21-1)(21-2) = 7980$
(c)	1st M1 product of 3 probabilities for $P(X=0)$ The three probabilities can be in any arrangement May be implied by $\frac{26}{95}$ 1st A1 $a = \frac{26}{95}$ oe must be clear this is the value for a 2nd M1 product of 3 probabilities for $P(X=1)$ or $P(X=2)$ or $\frac{91}{190}$ or $\frac{91}{570}$ or $\frac{21}{95}$ or $\frac{7}{95}$ oe seen. Condone incorrect labelling. The three probabilities can be in any arrangement 3rd M1 $\times 3$ or adding the 3 sets of the 3 fractions or $\frac{91}{190}$ or $\frac{21}{95}$ Condone incorrect labelling 4th dM1 their $P(X=0)$ + their $P(X=1)$ or $F(2) - P(X=2)$ (dep on 2nd M1 being scored) 2nd A1 $b = \frac{143}{190}$ oe must be clear this is the value for b **NB if** $a = 0.273\ldots$ and $b = 0.7526$ implies the method marks.

Qu	Scheme	Marks
4(a)	$S_{tw} = 2304.53 - \frac{297.8 \times 114.8}{15}$ or $S_{ww} = 6089.12 - \frac{297.8^2}{15}$	M1
	$S_{tw} = 25.367...$ **awrt 25.4**	A1
	$S_{ww} = 176.797$ **awrt 177**	A1
		(3)
(b)	$r = \frac{"25.367"}{\sqrt{5.3173 \times "176.797..."}}$	M1
	$= 0.82735....$ **awrt 0.827 or 0.828**	A1
		(2)
(c)	$b = \frac{"25.367..."}{5.3173} [= 4.77065...]$	M1
	$a = \frac{297.8}{15} - \frac{"25.367"}{5.3173} \times \frac{114.8}{15} [= -16.658....]$	M1
	b = 4.771 or better **or** a = –16.66 or better seen **and** $w = -16.7 + 4.77t$*	A1*cso
		(3)
(d)	[On average,] for each **cm/1 cm** of tail **length/*t*** the **weight/*w* increases** by **4.77 g/grams**	B1
		(1)
(e)	$w = -16.7 + 4.77 \times 2 [= -7.16]$ or $4.77 \times 2 [= 9.54]$ or $[t =] \frac{16.7}{4.77} [= 3.5]$ or sd = awrt 0.6	M1
	$[w =] -7.16$ or 9.54 < 16.7 or 2 < 3.5 which is negative/weight cannot be negative or for sd extrapolation since a 2 cm tail is (approx 9 sd)/(more than 3 sd) from the mean	A1
		(2)
(f)	0.827	B1ft
		(1)
(g)	$2y + 10 = -16.7 + 4.77(x + 6)$ oe	B1ft
		(1)
	Notes	**Total 13**
(a)	M1 for a correct expression for S_{tw} or S_{ww}	
	A1 awrt 25.4	
	A1 awrt 177	
(b)	M1 for a valid attempt at r with their S_{tw} not equal to 2304.53 and S_{ww} not equal to 6089.12	
	A1 (M2 on epen) awrt 0.827 or awrt 0.828	
(c)	1st M1 for a correct method to find the value of b	
	2nd M1 ft their b. For a correct method to find a. Minimum shown a = awrt 19.9 – "their b" × awrt 7.65 $[= -16.658]$	
	A1* Both method marks must be awarded, equation stated (no fractions) **and** sight of (4.771 or better) **or** (−16.66 or better)	
(d)	B1 For a suitable contextual comment that implies that as length increases by 1 cm weight increases by 4.77g. Allow multiples eg each 10 cm increase in tail length weight increases by 47.7g Allow in terms of t and w	
(e)	M1 for a correct method to calculate the value of w (condone if written as a fraction) or $4.77 \times 2 [= 9.54]$ or correct method to find tail length when w = 0 or sd = awrt 0.6	
	A1 Method mark must be awarded. For –7.16 or 9.54 < 16.7 or 2 < 3.5 **with** a relevant explanation stating that weight is negative. If sd = awrt 0.6 is given allow extrapolation since a 2 cm tail is (approx 9 sd)/(more than 3 sd) from the mean.	
(f)	B1ft follow through their answer to (b)	
(g)	B1 ISW no need to be simplified. Allow equivalent eg $y = \frac{-16.7 + 4.77(x + 6)}{2} - 5$ The correct simplified equation is $y = 2.385x + 0.96$ allow awrt 2.39 and 0.96 – 0.98	

Question Number	Scheme	Marks
5. (a)	[D = distance achieved] $P(D > 4.3) = P\left(Z > \frac{4.3-3.8}{0.9}\right)$ or $P(Z > 0.555\ldots)$	M1
	$= 1 - 0.7123$ (tables)	M1
	$= 0.2877$ (tables) or $0.289257\ldots$ (calc) awrt **0.288** or awrt **0.289**	A1
		(3)
(b)	$\frac{d-3.8}{0.9} = -0.8416$ (calc $-0.84162123\ldots$)	M1 ; B1
	$d = 3.0425\ldots$ awrt **3.04**	A1
		(3)
(c)	$P(D > g \mid D > 4.3) = \frac{P(D > g)}{P(D > 4.3) \text{ or (a)}}$ $\left[= \frac{1}{3}\right]$ (o.e.)	M1
	$\therefore P(D > g) = \frac{1}{3}$(a) $= 0.096419\ldots$	A1ft (o.e)
	$\frac{g-3.8}{0.9} = 1.302228...$	dM1
	so $g = 4.97200..$ awrt **4.97** or awrt **4.98**	A1
		(4)
(d)	P(no gold medals) $= \left(\frac{2}{3}\right)^3$	M1
	P(at least one gold) $= 1 - \left(\frac{2}{3}\right)^3$	M1
	$= \frac{19}{27}$	A1
		(3)
		[13]

	Notes
(a)	1st M1 for standardising 4.3 with 3.8 and 0.9 (allow $\pm$) 2nd M1 for $1 - p$ (where $0.7 < p < 0.8$) A1 for awrt 0.288 or 0.289 (calc. 0.289257) (correct answer only 3/3)
(b)	M1 for standardising with d, 3.8 and 0.9 and setting equal to a z value $0.8 < \lvert z \rvert < 0.9$ B1 for $z = \pm 0.8416$ or better used A1 for awrt 3.04 (condone $d \geqslant \ldots$)
Ans only	For awrt 3.0425 or 3.0426 score 3/3 For awrt 3.04 score M1B0A1
(c)	1st M1 for either expression for the conditional prob. [or sight of $\frac{1}{3}$(a)] (ft their answer to (a) to 2 sf) 1st A1ft for $P(D > g) = 0.096$ or better (0.289 gives 0.09633… calc 0.096419…) The $P(D > g)$ may be clearly shown on a diagram. 1st M1A1 can be awarded for $P(D > g) = \frac{1}{3}$(a) or for $P(D < g) = 1 - \frac{1}{3}$(a) [ft their (a) to 2 sf] 2nd dM1 (dep on 1st M1) for standardising with g, 3.8 and 0.9 and put equal to a z value where $\lvert z \rvert > 1$ 2nd A1 for awrt 4.97 or 4.98 (Correct answer with no incorrect working seen 4/4) (condone $g \geqslant \ldots$)
SC	**(Medals v Certificates)** 1st B1 for $[P(D > g) =] \frac{1}{3} \times 0.8 = \frac{4}{15}$ or 0.267 (score as 1st M0 1st A1) 2nd B1 for g = awrt 4.36 (4.358 tables, 4.3606..calc) (score as 2nd M0 2nd A1)
(d)	1st M1 for a correct probability of no gold medals or 2 of: $3\left(\frac{2}{3}\right)^2 \times \frac{1}{3}$ or $3\left(\frac{1}{3}\right)^2 \times \frac{2}{3}$ or $\left(\frac{1}{3}\right)^3$ 2nd M1 for $1 - p^3$ or $3(p)^2(1-p) + 3p(1-p)^2 + (1-p)^3$ where $0 < p < 1$ A1 for $\frac{19}{27}$ (or exact equivalent) only e.g. $0.\dot{7}0\dot{3}$

Question Number	Scheme	Marks
6(a)	$\left[\mathrm{E}\left(R^2\right)=\right]2^2\times0.25+3^2\times0.3+4^2\times0.15+5^2\times0.1+6^2\times0.2$ (= 15.8*)	B1cso*
		(1)
(b)	$\left[\mathrm{sd}\ (R)=\right]\sqrt{15.8-3.7^2}$	M1
	$=\sqrt{2.11}$	
	Standard deviation = 1.4525…. awrt 1.45	A1
		(2)
(c)	$d=1$	B1
		(1)
(d)	$0.1+0.2+0.1+a+b=1$ oe	M1
	$2\times0.1+3\times0.2+4\times0.1+5a+6b=4.55$ oe	M1
	$5(0.6-b)+6b=3.35$ **or** $5a+6(0.6-a)=3.35\ \Rightarrow a=0.25$ **or** $b=0.35$	M1
	$c=0.4+"0.25"$ **or** $c=1-"0.35"$	M1
	$c=0.65$ oe	A1
		(5)
(e)	$0.9\times0.75\times0.1$	M1
	= 0.0675	A1
		(2)
(f)	For identifying that if Jessie scores 2, Pabel has no spin oe may be implied	M1
	$[0.10\times0+]0.2\times0.3+0.1\times0.15+"0.25"\times0.1+"0.35"\times0.2$	M1
	= 0.17	A1
		(3)
	Notes	**Total 14**

(a)	**B1**	Correct calculation with all products seen (allow 1 + 2.7 + 2.4 + 2.5 + 7.2) Figures may be seen in table before part (a). Condone missing addition signs if products seen in table.
(b)	**M1**	Use of formula including the square root
	A1	awrt 1.45 (correct answer with no working scores M1A1)
(c)	**B1**	For 1
(d)	**M1**	Allow equivalents eg $a+b=0.6$
	M1	Allow equivalents eg $5a+6b=3.35$
	M1	Correct method to eliminate a or b (implied by a correct value for a or b) This mark can still be scored even if the method leads to a value of a or b which is not a probability. May see $a = c - 0.4$ to eliminate a or $b = 1 - c$ used to eliminate b
	M1	A complete method for finding the value of c (condone using any value of a and b for this mark)
	A1	0.65 oe
(e)	**M1**	For the product of 3 probabilities
	A1	0.0675 or exact equivalent fraction eg $\frac{27}{400}$
(f)	**M1**	Identifying that if Jessie scores 2, there is only one spin or the 4 correct possibilities only
	M1	At least 3 correct non-zero probability products ft their a and b (an answer of 0.195 scores M0M1A0)
	A1	0.17