1	(i)		Mean $= \frac{759.00}{60} = £12.65$ Sxx $= 11736.59 - \frac{759^2}{60} = 2135.24$ s $= \sqrt{\frac{2135.24}{59}} = £6.02$	B1 M1 A1 **[3]**	Ignore units For Sxx CAO ignore units Allow more accurate answers	**CAO** Do not allow 759/60 as final answer but allow $12\ ^{13}/_{20}$ M1 for 11736.59 - 60 × their mean^2 BUT NOTE M0 if their $S_{xx} < 0$ For s^2 of 36.2 (or better) allow M1A0 with or without working For RMSD of 5.97 or 5.96 (or better) allow M1A0 provided working seen For RMSD^2 of 35.6 (or better) allow M1A0 provided working seen
	(ii)		New mean = 12.65 × 1.02 = £12.90 New sd = 6.02 × 1.02 = £6.14	B1 B1 **[2]**	FT their mean Awrt 12.90 Allow 12.9 FT their sd	If candidate 'starts again' only award marks for CAO **Deduct at most 1 mark overall in whole question for overspecification of Mean and 1mark overall for SD**
	(iii)		New mean = 12.65 + 0.25 = £12.90 New sd = £6.02	B1 B1 **[2]**	FT their mean Awrt 12.90 FT their sd (unless negative) Awrt 6.02	If candidate 'starts again' only award marks for CAO Allow sd unchanged (or similar)

2	(i)		P(X=1) = P(g,b)+P(b,g)+P(b,b,g)+P(b,b,b,g) $= \frac{1}{4}+\frac{1}{4}+\frac{1}{8}+\frac{1}{16}=\frac{11}{16}$ OR P(X=1) =1- P($X\neq1$) =1 - (P(bbbb)+P(ggb)+P(gggb)+P(gggg)) $=1-\left(\frac{1}{16}+\frac{1}{8}+\frac{}{16}+\frac{1}{16}\right)=\frac{11}{16}$	M1 M1 A1 **[3]**	For any two correct fractions For all four correct fractions *NB Answer given*	Must have correct ref to numbers of boys and girls, not just fractions With no extras Accept 0.6875, not 0.688. Watch for use of B(4, 0.5) P($X\leq2$)=0.6875 which gets M0M0A0.
	(ii)		E(X) = $(0\times\frac{1}{16})+(1\times\frac{11}{16})+(2\times\frac{1}{8})+(3\times\frac{1}{16})+(4\times\frac{1}{16})$ $=1\frac{3}{8}=1.375$ E(X^2) = $(0\times\frac{1}{16})+(1\times\frac{11}{16})+(4\times\frac{1}{8})+(9\times\frac{1}{16})+(16\times\frac{1}{16})$ $=2\frac{3}{4}=2.75$ Var (X) = $2\frac{3}{4}-\left(1\frac{3}{8}\right)^2=\frac{55}{64}=0.859$	M1 A1 M1 M1 A1 **[5]**	For Σrp (at least 3 terms correct) A1 CAO **Allow 1.38, not 1.4** For Σr^2p (at least 3 terms correct) M1dep for – their E(X)² A1 FT their E(X) provided Var(X) > 0 **0.86, not 0.9**	Allow 22/16 Use of E(X-μ)^2 gets M1 for attempt at (x-μ)^2 should see $(-1.375)^2$, $(-0.375)^2$, $(0.625)^2$, 1.625^2, 2.625^2 (if E(X) correct but FT their E(X)) (all 5 correct for M1), then M1 for $\Sigma p(x-\mu)^2$ (at least 3 terms correct) Division by 5 or other spurious value at end gives max M1A1M1M1A0, or M1A0M1M1A0 if E(X) also divided by 5. Unsupported correct answers get 5 marks. **Using 1.38 gets Var of 0.8456 gets A1**

3 (i)	Mean $= \frac{1\times10+2\times40+3\times15+4\times5}{70}=\frac{155}{70}=2.214$ S_{xx} = $1^2\times10+2^2\times40+3^2\times15+4^2\times5-\frac{155^2}{70}=385-343.21=41.79$ s = $\sqrt{\frac{41.79}{69}}=0.778$	M1 A1 CAO M1 for Σfx^2 s.o.i. M1 for attempt at S_{xx} Dep on first M1 A1 CAO If 0.778 or better seen ignore previous incorrect working (calculator answer) Allow final answer to 2 sig fig (www)	**5**	For M1 allow sight of at least 3 double pairs seen from $1\times10+2\times40+3\times15+4\times5$ with divisor 70. Allow answer of 155/70 or 2.2 or 2.21 or 31/14 oe For 155/70 = eg 2.3 , allow A1 isw M1 for $1^2\times10+2^2\times40+3^2\times15+4^2\times5$ with at least three correct terms Using exact mean leads to S_{xx} = 41.79 , s=0.778, Using mean 2.214 leads to S_{xx} = 41.87 , s=0.779, Using mean 2.21 leads to S_{xx} = 43.11 and s = 0.790 Using mean 2.2 leads to S_{xx} = 46.2 and s = 0.818 Using mean 2 leads to S_{xx} = 105 and s = 1.233 All the above get M1M1A1 except the last one which gets M1M1A0 RMSD(divisor *n* rather than *n* – 1) =√(41.79/70) = 0.772 gets M1M1A0 Alternative method, award M1for at least 3 terms of and second M1 for all 4 terms of $(1-2.214)^2\times10+(2-2.214)^2\times40+(3-2.214)^2\times15+(4-2.214)^2\times5(=41.79)$ NB Allow full credit for correct answers without working (calculator used)
(ii)	Mean would decrease Standard deviation would increase	B1 B1	**2**	Do not accept increase/decrease seen on their own – must be linked to mean and SD. Allow eg 'It would skew the mean towards zero' And eg ' It would stretch the SD' SC1 for justified argument that standard deviation might either increase or decrease according to number with no eggs (n≤496 increase, n≥497 decrease)
		TOTAL	**7**	

4 (i)	$2k + 6k + 12k + 20k + 30k = 1,\ 70k = 1$ $k = \frac{1}{70}$	M1 A1 NB **ANSWER GIVEN**	**2**	For five multiples of k (at least four correct multiples) Do not need to sum or =1 for M1 Condone omission of either $70k = 1$ or $k = 1/70$ but not both Condone omission of k: 2+6+12+20+30=70 Allow substitution of $k = 1/70$ into formula and getting at least four of 2/70, 6/70, 12/70, 20/70, 30/70 for M1 and 2/70+6/70+12/70+20/70+30/70 = 1 for A1
(ii)	$E(X) = 1\times\frac{2}{70}+2\times\frac{6}{70}+3\times\frac{12}{70}+4\times\frac{20}{70}+5\times\frac{30}{70}=4$ $E(X^2) =$ $1\times\frac{2}{70}+4\times\frac{6}{70}+9\times\frac{12}{70}+16\times\frac{20}{70}+25\times\frac{30}{70}=\frac{1204}{70}=17.2$ $Var(X) = 17.2 - 4^2 = 1.2$	M1 for Σrp (at least 3 terms correct) A1 CAO M1 for $\Sigma r^2 p$ (at least 3 terms correct) M1dep for - their $E(X)^2$ A1 FT their E(X) but not an error in $E(X^2)$ provided $Var(X) > 0$	**5**	280/70 scores M1A0 USE of $E(X-\mu)^2$ gets M1 for attempt at $(x-\mu)^2$ should see $(-3)^2$, $(-2)^2$, $(-1)^2$, 0^2, 1^2 (if $E(X)$ correct but FT their $E(X)$) (all 5 correct for M1), then M1 for $\Sigma p(x-\mu)^2$ (at least 3 terms correct with their probabilities) Allow all M marks with their probabilities, (unless not between 0 and 1, see below for all probs 1/70). Division by 5 or other spurious value at end gives max M1A1M1M1A0, or M1A0M1M1A0 if $E(X)$ also divided by 5. Unsupported correct answers get 5 marks. SC2 for use of 1/70 for all probabilities leading to E(X) = 3/14 and Var(X) = 145/196 = 0.74
		TOTAL	**7**	

5 **(i)**	$4k + 6k + 6k + 4k = 1$ $20k = 1$ $k = 0.05$	M1 A1 **NB Answer given**	**2**
(ii)	$E(X) = 1\times0.2+2\times0.3+3\times0.3+4\times0.2 = 2.5$ (or by inspection) $E(X^2) = 1\times0.2+4\times0.3+9\times0.3+16\times0.2 = 7.3$ Var(X) = $7.3 - 2.5^2 = 1.05$	M1 for Σrp (at least 3 terms correct) A1 CAO M1 for $\Sigma r^2 p$ (at least 3 terms correct) M1dep for – their $E(X)^2$ A1 FT their E(X) provided Var(X) > 0	**5**
		TOTAL	**7**

6 (i)	Mean = $\frac{0\times37+1\times23+2\times11+3\times3+4\times0+5\times1}{75}=\frac{59}{75}=0.787$ S_{xx} = $0^2\times37+1^2\times23+2^2\times11+3^2\times3+4^2\times0+5^2\times1-\frac{59^2}{75}=72.59$ $s=\sqrt{\frac{72.59}{74}}=0.99$	M1 A1 M1 for Σfx^2 s.o.i. M1 *dep* for good attempt at S_{xx} BUT NOTE M1M0 if their $S_{xx} < 0$ A1 CAO	**5**
(ii)	New mean = 0.787 × £1.04 = £0.818 or 81.8 pence New s = 0.99 × £1.04 = £1.03 or 103 pence	B1 ft their mean B1 ft their s B1 for correct units *dep* on at least 1 correct (ft)	**3**
		TOTAL	**8**