OCR Maths S1

Mark Scheme Pack

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Note: "(3 sfs)" means "answer which rounds to ... to 3 sfs". If correct ans seen to $\geq$ 3sfs, ISW for later rounding

1 (i) Σd^2 = 14	M1		Subtr & squ 5 pairs & add
$1 - \frac{6 \times \textit{their}\ 14}{5 \times (25-1)}$ = 0.3	A1		
	M1		dep 1st M1
	A1	4	
			$S_{xy} = 48 - \frac{15\text{x}15}{5}$ } { = 3 } $S_{xx} = 55 - \frac{15^2}{5}$ } M1 { = 10 } A1 $S_{yy} = 55 - \frac{15^2}{5}$ } { = 10 } their $\frac{S_{xy}}{\sqrt{(S_{xx}S_{yy})}}$ M1dep = 0.3 A1
(ii) Reverse rankings attempted	M1		3 correct
2 5 3 4 1	A1	2	T & I to make $\Sigma d^2 = 40$: 2 mks or 0 mks
	6		
2 (i) (a) Geo(0.14) stated in (a) or (b)	B1		or 0.86^nx0.14 or 0.14^nx0.86 in (a) or $\geq$ M1 in (b) or Geo(0.86) stated in (a) or (b)
$(0.86)^4$ x 0.14	M1		
= 0.0766 (3 sfs)	A1	3	No wking: 0.077: B1M1A0
(b) $1 - 0.86^7$	M2		$1 - 0.86^8$: M1
or 0.14 + 0.86x0.14…+ 0.86^6x0.14			+8th term (r = 7 or 0) or 1 missing term: M1
= 0.652 (3 sfs)	A1	3	
(ii) 1/0.14	M1		
= $^{50}/_{7}$ or 7.14 (3 sfs)	A1	2	
	8		
3 (i) (a) B(16, 0.35) stated	B1		Or implied by use of tables or 0.35^ax0.65^b (a+b = 16) in (a) or (b)
1 – 0.8406	M1		Allow 1 – 0.9329 or 0.0671 Or complete method using formula, P(r = 8-16 or 9-16) or 1-P(r = 0-7 or 0-8)
= 0.159 (3 sfs)	A1	3	
(b) 0.9771 – 0.1339	M1		Allow 0.9771 – 0.2892 Or complete method using formula (r = 4-9)
= 0.843 (3 sfs)	A1	2	
(ii) $^{16}C_6(0.38)^6(0.62)^{10}$	M2		Absent or incorr coeff : M1 or $^{16}C_6(0.38)^{10}(0.62)^6$: M1
= 0.202 (3 sfs)	A1	3	
	8		
4 (i) Correct subst in $\geq$ two S formulae	M1		Any correct version
$\frac{14464.1 - \frac{265 \times 274.6}{5}}{\sqrt{\left(14176.54 - \frac{265^2}{5}\right)\left(15162.22 - \frac{274.6^2}{5}\right)}}$	M1		or $\frac{14464.1 - 5 \times 53 \times 54.92}{\sqrt{(14176.54 - 5 \times 53^2)(15162.22 - 5 \times 54.92^2)}}$ or fully correct method with $(x - \bar{x})^2$ etc
= –0.868 (3 sfs)	A1	3	
(ii) No difference oe	B1	1	Or slightly diff or more acc because of rounding errors when mult by 2.54 oe Not just "more accurate"
(iii)Choose y on x stated	B1ind		or implied, eg by S_{xy}/S_{xx} or $y = ax + b$

$\dfrac{14464.1 - \dfrac{265 \times 274.6}{5}}{14176.54 - \dfrac{265^2}{5}}$ or -0.682	M1	If state x on y, but wking is y on x: B1 or their $\dfrac{-89.7}{131.54}$ seen or $\dfrac{14464.1 - 5 \times 53 \times 54.92}{14176.54 - 5 \times 53^2}$ or correct subst into a correct formula $\dfrac{S_{xy}}{S_{xx}}$
$y - {}^{274.6}/_{5} = (\text{their} - 0.682)(x - {}^{265}/_{5})$ $y = 91(.1) - 0.68(2)\,x$	M1ind A1 5	or $a = {}^{274.6}/_{5}$ - (their $-$ 0.682) x ${}^{265}/_{5}$ Simplif to 3 terms. Coeffs to $\geq$ 2 sfs
49.9 (3sfs) or 50	A1	cao Use of x on y: equiv M mks as above
	9	
5 (i) Read at 300 or 300.25 and 900 or 900.75 44.5 to 45.5 and 69 to 69.9 IQR 23.5 to 25.4	M1 A1 A1 3	or 44-46 and 68-70 incl. dep A1 Must look back, see method. No wking, ans in range: M1A1A1
(ii) 0.6 or 60% CF 720 63 to 64	M1 M1 A1 3	Seen or implied Seen or implied 55.5 to 56: SC B1
(iii) 1200 – 860 = 340	M1 A1 2	Allow 1200 – (850 to 890) 310 to 350
(iv) 340/1200 0.283^5 = 0.00183	M1 M1dep A1 3	their (iii)/1200 [their (iii)/1200]^5 exactly Allow 0.00114 to 0.00212 $\geq$ 2 sfs ..... ${}^{340}C_5/{}^{1200}C_5$ M1
(v) Incorrect reason or ambiguity: B0B0. Otherwise: Too low, or should be 26 or 27 or 2 or 3 higher	B2 2	eg IQR = 55–35 = 20 or IQR = value >27 or new info' implies straight line: B1 or originally, majority in range 35 – 55 are at top of this range: B1
	13	
6 (i) $a = {}^{4}/_{5}$, $b = {}^{1}/_{5}$ $c = ¼$, $d = ¾$ $e = ¾$, $f = ¼$	B1 B1B1 B1 4	Or : B1 { ie: a, b : B1 B1 { another pair : B1B1 B1B1 { third pair : B1
(ii) ${}^{1}/_{2}$x ${}^{4}/_{5}$x${}^{1}/_{2}$ + ${}^{1}/_{2}$x${}^{1}/_{5}$x ${}^{1}/_{4}$ + ${}^{1}/_{2}$x ${}^{3}/_{5}$x ${}^{3}/_{4}$ $= \frac{9}{20}$ (**AG**) with no errors seen	M2 A1 3	M1: one correct product (M2 needs +) ft their values for M mks only
(iii) 1/10 + 9/20 + k + 1/5 = 1 oe or ${}^{1}/_{2}$x${}^{1}/_{5}$x${}^{3}/_{4}$ + ${}^{1}/_{2}$x${}^{3}/_{5}$x${}^{1}/_{4}$ + ${}^{1}/_{2}$x${}^{2}/_{5}$x${}^{1}/_{2}$ k = ¼ oe	M1 A1 2	ft their values for M mk only
(iv) $\Sigma x\text{p}(x)$ $= 1\frac{3}{4}$ oe $\Sigma x^2\text{p}(x)$ [$= 3\frac{17}{20}$] $\Sigma x^2\text{p}(x)$ – (their μ)^2 63/80 or 0.788 (3 sfs)	M1 A1 M1 M1ind A1 5	Allow omit 1st term only. Not ISW, eg ÷ 4 cao Allow omit 1st term only. Not ISW, eg ÷ 4 Subtract (their μ)^2, if result +ve Follow their k for M mks only $\Sigma(x - \mu)^2\text{p}(x)$: Single consistent pair: M1 Rest correct : M1
	14	

7 (i) ${}^{18}C_7$ or ${}^{18!}/_{(11!\ x7!)}$ = 31824	M1 A1	 2	 cao
(ii) ${}^5C_2 \times {}^6C_2 \times {}^7C_3$ or 5250 ÷ 31824 = 875/5304 or 5250/31824 oe or 0.165 (3 sfs)	M2 M1 A1	 4	M1: 1 correct ${}^nC_r$ or mult any three ${}^nC_r$s Divide by their (i). Indep If cancelled, must be clear have ÷ 31824 5 x 4 x 6 x 5 x 7 x 6 x 5 x 7! 18x17x 16 x 15 x 14 x 13 x 12 x $2!^2$x3! Correct 7 fractions mult: M1 x7!: M1} ÷ ($2!^2$x3!): M1}both dep any 7 fracts mult
(iii) 5 from W & 2 from (G + H) ${}^7C_5 \times {}^{11}C_2$ or 1155 ÷ 31824 = 385/10608 or 1155/31824 oe or 0.0363 (3 sfs)	M1 M1 M1 A1	 4	Seen or implied, eg by combs or list Divide by their (i). Indep 7 x 6 x 5 x 4 x 3 x 11 x 10 x 7! 18x17x16 x 15 x14 x 13 x 12 x 5! x 2! Correct 7 fractions mult: M1 x 7! : M1} ÷ (5! x 2!): M1} both dep any 7 fracts mult
(iv) (2, 2, 3) or (2, 3, 2) or (3, 2, 2) ${}^5C_2\times{}^6C_2\times{}^7C_3+{}^5C_2\times{}^6C_3\times{}^7C_2$ $+{}^5C_3\times{}^6C_2\times{}^7C_2$ (÷ 31824) = 175/442 or 12600/31824 oe or 0.396 (3 sfs)	M1 M2 A1	 4	Any one. Seen or implied eg by combs M1: one correct product. NOT ${}^5C_2\times{}^6C_2\times{}^7C_2$ (No mk for ÷ 31824) ~~Equiv method: ((ii) + etc) can imply M mks~~ 5 x 4 x 6 x 5 x 7 x 6 x 7! 18x17x16 x 15 x14 x 13 x $2!^2$x3! Correct 6 fractions mult: M1 x 7! : M1} ÷ ($2!^2$ x 3!) : M1}both dep any 6 fracts mult Complement method: Triple with total 7, incl at least one 0 or 1 or (0, 7) or (1, 6) seen or implied: M1 One correct prod seen, eg ${}^5C_0x{}^6C_2x{}^7C_5$ M1 Full correct method, incl "1 – " M1
	14		

1(i)	$^2/_3$+prod of 2 P's or 1– prod of 2 P's $^2/_3 + {}^1/_3 \times {}^3/_4$ or $1 - {}^1/_3 \times {}^1/_4$ $= {}^{11}/_{12}$ or 0.917 (3 sfs)	M1 M1 A1 **3**	or $^1/_3 \times {}^3/_4$ or $^1/_3 \times {}^1/_4$
(ii)	$^1/_3 \times p$ $^2/_3 + {}^1/_3 \times p = {}^5/_6$ oe $p = {}^1/_2$	M1 M1 A1 **3**	or $^1/_3(1-p)$ or $^1/_3(1-p) = 1 - {}^5/_6$ SW: ½ x $^1/_3 = {}^1/_6$ M2A0, unless clear this is a check
Total		**6**	
2(i)	124.5, 4.8	B1B1 **2**	for 4.8 allow "same"
(ii)	mean smaller or generally smaller or means similar or hts similar oe More widely spread or varied oe	B1f B1f **2**	Assume 2nd referred to unless clear 1st or less consistent or gter dispersion or further from mean, gter variance Not "range" greater Allow opposite if ft (i)
(iii)	("124.5" + 2 x 123)/3 = 123.5	M1 A1 **2**	or (50 x "124.5" + 100 x 123)/150 cao
Total		**6**	
3(i)	$^3/_5 \times {}^2/_4 \times {}^1/_3$ or $^2/_5 \times {}^3/_4 \times {}^1/_3$ x 2 or + $^3/_5 \times {}^2/_4 \times {}^1/_3 + {}^2/_5 \times {}^3/_4 \times {}^1/_3$ $= {}^1/_5$ AG	M1 M1 M1 A1 **4**	or $^1/_{10}$ <u>from tree</u> add 2 equal products of 3 probs all correct Must see correct working NB incorrect methods eg $^3/_5 x^2/_4 x^2/_3$
(ii)	Σxp = 4 $\Sigma x^2 p$ (= 17) $- \mu^2$ = 1	M1 A1 M1 M1 A1 **5**	$\geq$ 3 terms added. Allow arith errors. $\geq$ 3 terms added. Allow arith errors Indep if +ve result $\Sigma(x-\mu)^2 p$ M2; 3 terms: M1 dep +ve result Σxp & $\Sigma x^2 p$, if ÷ eg 4: M0A0 ($- \mu^2$ poss M1)
Total		**9**	

4(i)(a)	Total area = 60 sqs Recog that total area reps 300 8 x 300/60 = 40	M1 M1 M1 A1 **4**	Attempt total area, eg 15000 or 15 cm^2 eg 1 squ = 5 or 15000 ÷ (300 or 50) or 2000/50 cao
(b)	Splitting classes 1.2x4x5 or 0.8x6x5 oe 48	M1 M1 A1 **3**	 or 0.3x16x5 or 0.4x12x5 or 24 NB other correct eg $2x4x5 + {}^{4}/_{5}x2x5$ Alt method: estimate: 46-50 SC B1
(ii)(a) (b)	Box & whisker Cum freq diag	B1 **1** B1 **1**	
Total		**9**	
5(i)(a)	$({}^{3}/_{5})^4 \times {}^{2}/_{5}$ = 0.0518 (3sfs) or $^{162}/_{3125}$ oe	M1 A1 **2**	Allow index 3 or 5
(b)	$({}^{3}/_{5})^4$ $1 - ({}^{3}/_{5})^4$ = 0.870 (3 sfs) or $^{544}/_{625}$ oe	M1 M1 A1 **3**	$^{2}/_{5} + {}^{3}/_{5}x^{2}/_{5} + ({}^{3}/_{5})^2x^{2}/_{5} + ({}^{3}/_{5})^3x^{2}/_{5}$: M2 (1extra or omit or wrong: M1) Allow $1 - ({}^{3}/_{5})^3$ or $1 - ({}^{3}/_{5})^5$
(ii)(a)	B(5, $^{2}/_{5}$) stated 5 x $^{2}/_{5}$ x $({}^{3}/_{5})^4$ or 0.3370 – 0.0778 = 0.259 (3 sfs) or $^{162}/_{625}$ oe	M1 M1 A1 **3**	or $({}^{5}C_{a}$ or $^{5}C_{b})x({}^{2}/_{5})^{a}x({}^{3}/_{5})^{b}$ & $a + b = 5$
(b)	"0.259" x $^{2}/_{5}$ = 0.104 (3 sfs) or $^{324}/_{3125}$ oe	M1 A1f **2**	eg ft: (a) 0.0518 → 0.0207 (a) 0.922 → 0.369
Total		**10**	
6(i)	$^{4}C_3 \times {}^{7}C_4$ = 140	M1M1 A1 **3**	M1 either comb. 140/330: M1M1
(ii)	$^{3}C_2 \times {}^{6}C_4$ or $\frac{{}^{3}C_2}{{}^{4}C_3}$ or $\frac{{}^{6}C_4}{{}^{7}C_4}$ $\frac{{}^{3}C_2 \times {}^{6}C_4}{\text{"140"}}$ or $^{3}/_{4} \times (1 - {}^{4}/_{7})$ = $^{9}/_{28}$ oe or 0.321 (3 sfs)	M1 M1 A1 **3**	or $^{3}C_2(x..)/$"140" or $(\ldots x)^{6}C_4/$"140" or $({}^{3}C_2+{}^{6}C_4)/$"140" or (3+15)/"140" or $^{3}/_{4}$ or $1-{}^{4}/_{7}$ seen all correct
(iii)	$^{3}C_2x\ {}^{6}C_4$ (or i x ii) or $({}^{3}C_3x)^{7}C_4$ or 45 or 35 or $^{1}/_{4}x^{4}C_3x^{7}C_4$ or $^{3}/_{4}x\ {}^{4}C_3x^{6}C_4$ $^{3}C_2x^{6}C_4+({}^{3}C_3x)^{7}C_4$ or "140" $-{}^{3}C_2x^{6}C_3$ = 80	M1 M1 A1ft **3**	1 correct prod or "140"– any prod or $^{1}/_{4}x^{4}C_3x^{7}C_4 + {}^{3}/_{4}x\ {}^{4}C_3x^{6}C_4$ ft only "140"
Total		**9**	

7(i)	Binomial $n = 10$, $p = 0.9$ Each seed equally likely germ or P(germ) same for all seeds oe Seeds independent oe	B1 B1 B1 B1 **4**	 Both requ'd. Ignore $q = 0.1$ or seeds grown in same conditions Context nec'y for each B1
(ii)	0.0702 (3 sfs)	 B2 **2**	0.07 or 0.2639: B1 Σ or 1-Σ: 1 term extra or omit or wrong: M1
(iii)	1 – "0.0702" $0.9298^{20} + {}^{20}C_1 \times 0.0702 \times 0.9298^{19}$ = 0.585 (3 sfs)	 M1 M1M1 A1 **4**	 Or 0.9298 or 0.93(0) seen M1 each term cao eg ft (ii) 0.2639 → (iii) 0.0178 from correct wking: M3A0 $0.0702^{20}+{}^{20}C_1 \times 0.9298 \times 0.0702^{19}$ ($=2.25\times10^{-21}$): SC M1M1 NB ft (ii) for all M mks. But if 0.1, 0.9 used, must be clear using (ii) rounded
Total		**10**	

8(i)(a)	Ranks 1 2 3 4 5 6 7 8 9 9 8 7 6 5 4 3 2 1 3 2 1 5 4 7 8 6 9 7 8 9 5 6 3 2 4 1	M1 A1	Attempt ranks, same dir'n Correct ranks
	Σd^2 (= 16)	M1dep	Dep ranks attempted
	$r_s = 1 - \frac{6 \times \text{their } 16}{9 \times (9^2-1)}$ = 0.867 (3 sfs) or $^{13}/_{15}$ oe	M1dep A1 **5**	Correct formula with n = 9, dep M1M1
(b)	Countries with larger pops tend to have larger capital pops. oe	B1ft **1**	or ft (a) Must interp & refer to context. Not "Gd corr'n country & cap pops" Not "Gd agree't country & cap pops" Not "Gd rel'nship country & cap pops" Not "proportional"
(ii)	$\frac{1533.76 - (337.5 \times 28.3)/9}{\sqrt{((18959.11 - 337.5^2/9)(161.65 - 28.3^2/9))}}$ = 0.698 (3 sfs)	M1 A1 **2**	(= 472.51/√(6302.86x72.66)) Or correct subst in 2 "S" formulae, any version No wking: 0.7 M0A0; 0.70: M1A0
(iii)	Increase	B1 **1**	or nearer to 1
(iv)(a)	x on y Est country pop from cap or x from y oe	B1ind B1ind **2**	y indep or known or given or x unknown or x dep on y oe
(b)	any indication different context, eg "Africa", "remote areas" unreliable	B1 B1dep **2**	or reliable because r (or r_s) high: B1 or unreliable because r (or r_s) not hi: B1 "accurate": B0
Total		**13**	

Total 72 marks

Note: "(3 sfs)" means "answer which rounds to ... to 3 sfs". If correct ans seen to ≥ 3sfs, ISW for later rounding
Penalise 2 sfs only once in paper.

1(i)	Negative, because (grad or coeff of x in 1st equn or x-value or reg coeff or B or –0.6) is negative	B1 **1**	Neg because x incr & y decr
(ii)	x = -1.6 x 7.0 + 21 x = 9.8	M1 A1 **2**	Sub y=7.0 in 2nd eqn. Allow 1 sign error If sub in both must choose 2nd
(iii)	y = –0.6(-1.6y + 21) + 13 or similar $\bar{x}$ = 5, $\bar{y}$ = 10	M1 A1A1 **3**	Obtain correct eqn in 1 variable. Allow 1 num'l error Allow without bars
Total		**6**	
In qus 2 & 3 "prod" means "product of two probabilities"			
2(i)	$^4/_7$ or 0.571 (3 sfs)	B1 **1**	
(ii)	$^5/_8$ x $^4/_7$ + $^3/_8$ x $^5/_8$ = $^{265}/_{448}$ or 0.592 (3 sfs)	M1M1 A1 **3**	M1: one correct prod or add any two prods M1: all correct
(iii)	$^3/_8$ x $^5/_8$ + $^5/_8$ x $^3/_7$ = $^{225}/_{448}$ or 0.502 (3 sfs)	M1M1 A1 **3**	M1: one correct prod or add any two prods M1: all correct
Total		**7**	
3(i)	$\frac{7!}{3! \times 2(!)}$ = 420	M1M1 A1 **3**	M1: 7!/(a factorial); or … ÷ (3! x 2(!)) M1: all correct
(ii)	$\frac{5!}{2(!)}$ = 60	M1 A1 **2**	M1: 5! seen (not part of a C) or 5 x 4! or 120 seen or … ÷ 2(!) alone
(iii)	1 – $^4/_7$ x $^3/_6$ or 1 – $^4C_2$ / $^7C_2$ or 1 – $^4P_2$ / $^7P_2$ or $^3/_7$ x $^2/_6$ + $^3/_7$ x $^4/_6$ + $^4/_7$ x $^3/_6$ oe or $^3C_2$ / $^7C_2$ + $^3C_1$x$^4C_1$ / $^7C_2$ = $^5/_7$ or 0.714 (3 sfs)	M1M1 A1 **3**	M1:1– prod or 1-.../$^7C_2$ or 1–$^4C_2$ /.. (or Ps) or add 3 prods or add 2 correct prods or $^3C_2$ / $^7C_2$ or $^3C_1$x$^4C_1$ / $^7C_2$ or add ≥ 5 out of 7 correct prods M1: all correct
Total		**8**	

4(i)	0.4207 or 0.421 (3 sfs) or $0.8^{25}+25x0.8^{24}x0.2 + .. {}^{25}C_4x0.4^{21}x0.2^4$ 0.579(3)	B1 B1 **2**	or 1 – 0.6167 or 0.3833 (3 sfs) or 1- (6 correct terms, 0 to 5)
(ii)	${}^{10}C_3$ x $(1-0.27)^7$ x 0.27^3 = 0.261 (3 sfs)	M1 A1 **2**	
(iii)	Allow "=" thro'out $0.73^9 = 0.059$ | $1 - 0.73^n > 0.95$ $0.73^{10} = 0.043$ | or $0.73^n < 0.05$ | $n$log0.73 < log0.05 oe $n = 10$	 M1 M1 A1 **3**	or 1 - ${}^nC_0$ x 0.27^0 x $0.73^n > 0.95$ oe allow incorrect sign M1 must be correct ft (1 – 0.27) from (ii) for M1M1 10 with incorrect sign in wking: SCB2 10 with just $0.73^9 = 0.059$: M1M1A1
Total		**7**	
5(i)	$^1/_3 + {}^1/_4 + p + q = 1$ oe $0 \times {}^1/_3 + 1 \times {}^1/_4 + 2p + 3q = 1{}^1/_4$ oe equalize coeffs, eg mult eqn (i) by 2 or 3 Or make p or q subject of (i) or (ii) $p = {}^1/_4$, $q = {}^1/_6$ oe	B1 B1 M1 A1A1 **5**	 allow one error. ft their equns subst or subtr not nec'y
(ii)	Σx^2p (not /4 or /3 etc) $(= 2^3/_4)$ – $(1^1/_4)^2$ = 1.1875 or $1^3/_{16}$ oe sd = √(their 1.1875) = 1.09 (3 sfs)	M1 M1 A1 B1f **4**	≥ 2 non-zero terms correct. dep +ve result indep if +ve result or Σx-$1^1/_4)^2p$ (≥ 2 (non-0) terms correct): M2 ft (i) ($0 \leq p, q < 1$) or letters p, q both M1s cao dep 1st M1 &√(+ve no.) eg √2.75 = 1.66
Total		**9**	

6(i)(a)	Ranks: 2 4 7 5 3 1 6 6 4 1 3 5 7 2 7 1 6 3 2 5 4 1 7 2 5 6 3 4 Σd^2 (= 60) $r_s = 1 - \frac{6\times 60}{7\times 48}$ $= -{}^{1}/_{14}$ or -0.071 (3 dps)	M1 A1 M1 M1 A1 **5**	$\geq$ 5 ranks correct in each set all correct dep ranks attempted even if opp orders, allow arith errors Correct formula with n = 7, dep 2nd M1 calc r for ranks: $S_{xx}=S_{yy}= 140 - 28^2/7$. $S_{xy} = 110-28^2/7$ (= 28) (= -2) corr subst in one corr S (any version):M1 corr subst in $r = S_{xy} / \sqrt{(S_{xx}S_{yy})}$:M1 -0.07 without wking: M1A1M2A0
(b)	Little (or no) connection (agreement, rel'nship) between dist and commission Allow disagreement	B1ft **1**	No mks unless $\lvert r_s\rvert \leq 1$ ft their r_s Must refer to context. Not "little corr'n between dist and com" not "strong disagreement"
(c)	Unchanged. No change in rank	B1B1 **2**	Ignore other comment
(ii)(a)	= –1	B1 **1**	indep
(b)	Close to –1 or, eg ≈ – 0.9	B1	cao not referring to "corr'n" rather than r allow "neg", not neg corr'n or neg skew
Total		**10**	

7(i)	Midpoints attempted ≥ 2 classes $\sum xf$ / 100 or $\sum xf$ / $\sum f$ attempted ≥ 2 terms *x* within class, not class width Mean = 27.2 (to 3 sfs) (not 27.25) art 27.2 from fully correct wking $\sum x^2 f$ or $\sum x - \bar{x})^2 f$ ≥ 2 terms $\sqrt{(\sum x^2 f /100 - \bar{x}^2)}$ or $\sqrt{((\sum x - \bar{x})^2 f /100)}$ or $/\sum f$ fully corr method, not √neg = 40.5 to 41.1 (3 sfs)	M1 M1 A1 M1 M1 A1 **6**	Correct (149.5) | With 150 | Tot = 2000 2720.5/100 | 2725/100 | Allow Ms & poss As 27.2 | 27.25 240702.25 | 242050 40.82 | 40.96 allow class widths for 2nd M1 only
(ii)	Recog LQ in 1st class & UQ in 3rd class Graph: Interp: Attempt 25(.25)th value LQ = 3.0 to 4.3 Attempt 75(.75)th value UQ =27 to 29 Subtract IQR = 23 or 24 or 25	B1 M1 M1 A1 **4**	 both nec'y dep B1or M1 integer. dep M2
(iii)(a)	Increase	B1 **1**	
(b)	Increase	B1 **1**	Ignore "probably" etc
(c)	No change	B1 **1**	
Total		**13**	
8(i)	Geometric. Each attempt (or result or try) indep	B1 B1 **2**	In context. Not "events,. trials, outcomes" . Ignore extra
(ii)(a)	$(^2/_3)^3 \times {}^1/_3$ $= {}^8/_{81}$ or 0.0988 (3 sfs)	M2 A1 **3**	$(^2/_3)^2 x {}^1/_3$ or $(^2/_3)^4 \times {}^1/_3$: allow other numerical "*p*" (0<*p*<1):M1
(b)	$(^2/_3)^3$ $1 - (^2/_3)^3$ $= {}^{19}/_{27}$ or 0.704 (3sfs)	M1 M1 A1 **3**	not $(^2/_3)^3 \times$ …. or $^1/_3 + {}^2/_3 x {}^1/_3 + (^2/_3)^2 x {}^1/_3$ M2 $1 - (^2/_3)^4$ or $1 - (\text{"}q\text{"})^4$ M1 or 3 terms, with 2 correct M1 or 3 correct terms + 1 extra M1 or "*p*" + "*qp*" + "q^2p" M1 or 1 – sum of 3 correct terms M1 "*p*" means num value, not $^1/_3$
(iii)	3	B1f **1**	or $^1/_{\text{"}p\text{"}}$
(iv)	$1 - {}^{19}/_{27}$ | (1 – 0.7037) or 0.2963 $(^8/_{27})^2 \times {}^{19}/_{27}$ | 0.2963^2 x 0.7037 $= {}^{1216}/_{19683}$ | = 0.0618 (3 sfs)	M1 M1 A1 **3**	ft (b) for M1M1 must see method if ft Allow figs rounded to 2 sfs for M1M1 cao. allow art 0.0618 or 0.0617
Total		**12**	

Total 72 marks

Note: "3 sfs" means an answer which is equal to, or rounds to, the given answer. If such an answer is seen and then later rounded, apply ISW. Penalize over-rounding only once in paper, except qu 8(ii).

1i	$1 - (^3/_{10} + {}^1/_5 + {}^2/_5)$ $^1/_{10}$	M1 A1 2	or $(^3/_{10} + {}^1/_5 + {}^2/_5) + p = 1$
ii	$^3/_{10} + 2 \times {}^1/_5 + 3 \times {}^2/_5$ $^{19}/_{10}$ oe	M1 A1 2	$\div 4$or6 $\Rightarrow$ M0A0
Total		**4**	
2i	x =20; y =11; x^2 =96; y^2 = 31; xy =52) S_{xx} = 16 or 3.2 S_{yy} = 6.8 or 1.36 S_{xy} = 8 or 1.6 $r = \frac{8}{\sqrt{(16 \times 6.8)}}$ or $\frac{1.6}{\sqrt{(3.2 \times 1.36)}}$ = 0.767 (3 sfs)	B1 B1 B1 M1 A1 5	dep $-1 \le r \le 1$ ft their S's (S_{xx} & S_{yy} +ve) for M1 only
ii	Small sample oe	B1f 1	
Total		**6**	
3i	120	B1 1	not just 5!
iia	3 x 4! or 72 (÷ 5!) $^3/_5$ oe	M1 A1 2	oe, eg $^{72}/_{120}$
b	Starts 1 or 21 (both) $^1/_5 + {}^1/_5 \times {}^1/_4$ = $^1/_4$ oe	M1 M1 A1 3	12,13,14,15, (≥2 of these incl 21, or allow 1 extra) can be implied by wking or 5x 3! or 4! + 3! (÷5!) complement: full equiv steps for Ms
Total		**6**	
4ia	**W & Y** ***oe***	B1 1	
b	**X** ***oe***	B1 1	
ii	Geo probs always decrease or Geo has no upper limit to x or $x \neq 0$	B1 1	Geo not fixed no. of values diags have fixed no of trials not Geo has +ve skew
iii	**W** Bin probs cannot fall then rise or bimodal	B1 B1dep 2	indep allow Bin probs rise then fall
Total		**5**	
5i	$\frac{2685 - \frac{140 \times 106.8}{8}}{3500 - \frac{140^2}{8}}$ or $\frac{2685 - 8 \times 17.5 \times 13.35}{3500 - 8 \times 17.5^2}$ = $^{136}/_{175}$ or 0.777 (3 sfs) $y - {}^{106.8}/_8 = 0.777(x - {}^{140}/_8)$ y=0.78x –0.25 or better or $y = {}^{136}/_{175}x - {}^1/_4$	M1 A1 M1 A1 4	Correct sub in any correct formula for b (incl. $(x - \bar{x})$ etc) or $a = {}^{106.8}/_8 - 0.777 \times {}^{140}/_8$ ft b for M1 ≥ 2 sfs sufficient for coeffs
ii	0.78 x 12 – 0.25 = 9.1 (2 sfs)	M1 A1f 2	M1: ft their equn A1: dep const term in equn
iiia b	Reliable Unreliable because extrapolating oe	B1 B1 2	Just "reliable" for both: B1
Total		**8**	

6i	Geo($^2/_3$) stated $(^1/_3)^3 \times {}^2/_3$ = $^2/_{81}$ or 0.0247 (3 sfs)	M1 M1 A1 3	or implied by $(^1/_3)^n \times {}^2/_3$

ii	$(^1/_3)^3$ $1 - (^1/_3)^3$ $^{26}/_{27}$ or 0.963 (3 sfs)	M1 M1 A1 3	or $^2/_3+^1/_3x^2/_3+(^1/_3)^2x^2/_3$: M2 one term omitted or extra or wrong: M1 $1 - (^1/_3)^4$ or $1- (^2/_3+^1/_3x^2/_3+(^1/_3)^2x^2/_3$):M1
iii	1 / 2/3 = 3/2 oe	M1 A1 2	
Total		**8**	
7i	$^2/_9$ or $^7/_9$ oe seen $^3/_9$ or $^6/_9$ oe seen $^1/_8$ or $^7/_8$ oe seen Correct structure All correct	B1 B1 B1 B1 B1 5	 ie 8 correct branches only, ignore probs & values including probs and values, but headings not req'd
ii	$^3/_{10}$ x $^7/_9$ + $^7/_{10}$ x $^3/_9$ + $^7/_{10}$ x $^6/_9$ $^{14}/_{15}$ or 0.933 oe	M2 A1 3	or $^3/_{10}x^7/_9$ + $^7/_{10}$ or $1 - ^3/_{10}$ x $^2/_9$ M1: one correct prod or any prod + $^7/_{10}$ or $^3/_{10}$ x $^2/_9$
iii	$^3/_{10}$ x $^2/_9$ x $^7/_8$ + $^7/_{10}$ x $^6/_9$ $^{21}/_{40}$ or 0.525 oe	M2 A1 3	M1: one correct prod cao
	No ft from diag except: with replacement: (i) structure: B1 (ii) $^{91}/_{100}$: B2 (iii) 0.553: B2		
Total		**11**	
8i	Med = 2 LQ = 1 or UQ = 4 IQR = 3	B1 M1 A1 3	cao or if treat as cont data: read cf curve or interp at 25 & 75 cao
ii	Assume last value = 7 (or eg 7.5 or 8 or 8.5) xf attempted $\geq$ 5 terms 2.6 or 3 sf ans that rounds to 2.6 x^2f or $\Sigma(x-m)^2f$ $\geq$ 5 terms $\sqrt{(x^2f/100 - m^2)}$ or $\sqrt{(\Sigma(x-m)^2f)/100}$ fully correct but ft m 1.6 or 1.7 or 3 sf ans that rounds to 1.6 or 1.7	B1 M1 A1 M1 M1 A1 6	stated, & not contradicted in wking eg 7-9 or 7,8, 9 Not just in wking allow "midpts" in xf or x^2f dep M3 penalize > 3 sfs only once
iii	Median less affected by extremes or outliers etc (NOT anomalies)	B1 1	or median is an integer or mean not int. or not affected by open-ended interval general comment acceptable
iv	Small change in var'n leads to lge change in IQR UQ for W only just 4, hence IQR exaggerated orig data shows variations are similar	 B1 1	 for Old Moat LQ only just 1 & UQ only just 3 oe specific comment essential
v	OM % (or y) decr (as x incr) oe Old Moat	B1 B1 2	ranks reversed in OM or not rev in W NIS
Total		**13**	

9i	${}^{11}C_5 \times (1/4)^6 \times (3/4)^5$ 0.0268 (3 sfs)	M1 A1 2	or $462 \times (1/4)^6 \times (3/4)^5$
ii	$q^{11} = 0.05$ or $(1-p)^{11} = 0.05$ $\sqrt[11]{0.05}$ $q = 0.762$ or 0.7616 . . . $p = 0.238$ (3 sfs)	M1 M1 A1 A1f 4	(any letter except p)$^{11} = 0.05$ oe oe or invlog$(\frac{\log 0.05}{11})$ ft dep M2
iii	$11 \times p \times (1-p) = 1.76$ oe $11p - 11p^2 = 1.76$ or $p - p^2 = 0.16$ $11p^2 - 11p + 1.76 = 0$ or $p^2 - p + 0.16 = 0$ $(25p^2 - 25p + 4 = 0)$ $(5p-1)(5p-4) = 0$ or $p = \frac{11 - \sqrt{(11^2 - 4 \times 11 \times 1.76)}}{2 \times 11}$ $p = 0.2$ or 0.8	M1 A1 A1 M1 A1 5	not $11pq = 1.76$ any correct equn after mult out or equiv with = 0 or correct fact'n or subst'n for their quad equ'n eg $p = \frac{1 \pm \sqrt{(1 - 4 \times 0.16)}}{2}$
Total		**11**	

Total 72 marks

Note: "3 sfs" means an answer which is equal to, or rounds to, the given answer. If such an answer is seen and then later rounded, apply ISW.

1	$(0\times0.1) + 1\times0.2 + 2\times0.3 + 3\times0.4$ $= 2(.0)$ $(0^2\times0.1) +1\times0.2 + 2^2\times0.3 + 3^2\times0.4$ (= 5) $- 2^2$ $= 1$	M1 A1 M1 M1 A1 5	$\geq$ 2 non-zero terms correct eg ÷ 4: M0 $\geq$ 2 non-zero terms correct ÷ 4: M0 Indep, ft their μ. Dep +ve result $(-2)^2\times0.1+(-1)^2\times0.2+0^2\times0.3+1^2\times0.4$:M2 $\geq$ 2 non-0 correct: M1 ÷ 4: M0
Total		**5**	
2	UK Fr Ru Po Ca 1 2 3 4 5 or 5 4 3 2 1 4 3 1 5 2 2 3 5 1 4 Σd^2 (= 24) $r_s = 1 - \frac{6 \times \text{"24"}}{5 \times (5^2-1)}$ $= -{}^1/_5$ or -0.2	 M1 A1 M1 M1 A1 5	Consistent attempt rank other judge RCFUP 3 5 2 1 4 3 1 4 5 2 1 2 3 4 5 5 4 3 2 1 All 5 d^2 attempted & added. Dep ranks att'd Dep 2nd M1 $\frac{43 - 15^2/5}{\sqrt{((55-15^2/5)(55-15^2/5))}}$ Corr sub in $\geq$ 2 S's M1 All correct: M1
Total		**5**	
3i	${}^{15}C_7$ or ${}^{15!}/_{7!8!}$ 6435	M1 A1 2	
ii	${}^6C_3 \times {}^9C_4$ or ${}^{6!}/_{3!3!} \times {}^{9!}/_{4!5!}$ 2520	M1 A1 2	Alone except allow ÷ ${}^{15}C_7$ Or ${}^6P_3 \times {}^9P_4$ or ${}^{6!}/_{3!} \times {}^{9!}/_{5!}$ Allow ÷ ${}^{15}P_7$ NB not ${}^{6!}/_{3!}\times{}^{9!}/_{4!}$ 362880
Total		**4**	
4ia	${}^1/_3$ oe	B1 1	B↔W MR: max (a)B0(b)M1M1(c)B1M1
b	P(BB) + P(WB) attempted $= {}^4/_{10} \times {}^3/_9 + {}^6/_{10} \times {}^4/_9$ or ${}^2/_{15} + {}^4/_{15}$ $= {}^2/_5$ oe	M1 M1 A1 3	Or ${}^4/_{10} \times {}^3/_9$ OR ${}^6/_{10} \times {}^4/_9$ correct NB ${}^4/_{10} \times {}^4/_{10} + {}^6/_{10} \times {}^4/_{10} = {}^2/_5$: M1M0A0
c	Denoms 9 & 8 seen or implied ${}^3/_9 \times {}^2/_8 + {}^6/_9 \times {}^3/_8$ $= {}^1/_3$ oe	B1 M1 A1 3	Or ${}^2/_{15}$ as numerator Or $\frac{{}^2/_{15}}{{}^4/_{10}}$ Or $\frac{{}^4/_{10}\times{}^6/_9\times{}^3/_8 + {}^4/_{10}\times{}^3/_9\times{}^2/_8}{\text{above} + {}^6/_{10}\times{}^5/_9\times{}^4/_8 + {}^6/_{10}\times{}^4/_9\times{}^3/_8}$ May not see wking
ii	P(Blue) not constant or discs not indep, so no	B1 1	Prob changes as discs removed Limit to no. of discs. Fixed no. of discs Discs will run out Context essential: "disc" or "blue" NOT fixed no. of trials NOT because without repl Ignore extra
Total		**8**	

5i	1991 100 000 to 110 000	B1 ind B1 ind 2	Or fewer in 2001 Allow digits100 to 110
iia	Median = 29 to 29.9 Quartiles 33 to 34, 24.5 to 26 = 7.5 to 9.5 140 to 155 23 to 26.3%	B1 M1 A1 M1 A1 5	 Or one correct quartile and subtr NOT from incorrect wking ×1000, but allow without Rnded to 1 dp or integer 73.7 to 77% : SC1
b	Older Median (or ave) greater } % older mothers greater oe} % younger mothers less oe}	B1 B1 B1 3	Or 1991 younger Any two Or 1991 steeper so more younger: B2 NOT mean gter Ignore extra
Total		**10**	

6ia	Correct subst in $\geq$ two S formulae $\dfrac{767-\dfrac{60\times72}{8}}{\sqrt{(1148-\dfrac{60^2}{8})(810-\dfrac{72^2}{8})}}$ or $\dfrac{227}{\sqrt{698}\sqrt{162}}$ = 0.675 (3 sfs)	M1 M1 A1 3	Any version All correct. Or $\dfrac{767\text{-}8x7.5x9}{\sqrt{((1148\text{-}8x7.5^2)(810\text{-}8x9^2))}}$ or correct substn in any correct formula for r
b	1 y always increases with x or ranks same oe	B1 B1 2	+ve grad thro'out. Increase in steps. Same order. Both ascending order Perfect RANK corr'n Ignore extra NOT Increasing proportionately
iia	Closer to 1, or increases because nearer to st line	B1 B1 2	Corr'n stronger. Fewer outliers. "They" are outliers Ignore extra
b	None, or remains at 1 Because y still increasing with x oe	B1 B1 2	Σd^2 still 0. Still same order. Ignore extra NOT differences still the same. NOT ft (i)(b)
iii	13.8 to 14.0	B1 1	
iv	(iii) or graph or diag or my est Takes account of curve	B1 B1 2	Must be clear which est. Can be implied. "This est" probably $\Rightarrow$ using equn of line Straight line is not good fit. Not linear. Corr'n not strong.
Total		**12**	
7i	P(contains voucher) constant oe Packets indep oe	B1 B1 2	Context essential NOT vouchers indep
ii	0.9857 or 0.986 (3 sfs)	B2 2	B1 for 0.9456 or 0.946 or 0.997(2) or for 7 terms correct, allow one omit or extra NOT 1 – 0.9857 = 0.0143 (see (iii))
iii	(1 – 0.9857) = 0.014(3) (2 sfs)	B1ft 1	Allow 1- their (ii) correctly calc'd
iv	B(11, 0.25) or 6 in 11 wks stated or impl $^{11}C_6 \times 075^5 \times 0.25^6$ (= 0.0267663) P(6 from 11) × 0.25 = 0.00669 or 6.69 x 10^{-3} (3 sfs)	B1 M1 M1 A1 4	or $0.75^a \times 0.25^b$ ($a + b = 11$) or $^{11}C_6$ dep B1
Total		**9**	

8i	$\sqrt{}0.04$ (= 0.2) $(1 - \text{their } \sqrt{}0.04)^2$ = 0.64	M1 M1 A1 3	
ii	$1 - p$ seen $2p(1 - p) = 0.42$ or $p(1 - p) = 0.21$ oe $2p^2 - 2p + 0.42(= 0)$ or $p^2 - p + 0.21(= 0)$ $\frac{2 \pm \sqrt{((-2)^2 - 4\times0.42)}}{2 \times 2}$ or $\frac{1 \pm \sqrt{((-1)^2 - 4\times0.21)}}{2 \times 1}$ or $(p-0.7)(p-0.3)=0$ or $(10p-7)(10p-3)=0$ $p = 0.7$ or 0.3	B1 M1 M1 M1 A1 5	M1 for either $2pq = 0.42$ or $pq = 0.21$ Allow $pq=0.42$ or opp signs, correct terms any order (= 0) oe Correct Dep B1M1M1 Any corr subst'n or fact'n Omit 2 in 2nd line: max B1M1M0M0A0 One corr ans with no or inadeq wking: SC1 eg $0.6 \times 0.7 = 0.42 \Rightarrow p = 0.7$ or 0.6 $p^2 + 2pq + q^2 = 1$ B1 $p^2 + q^2 = 0.58$ } $p = 0.21/q$ } $p^4 - 0.58p^2 + 0.0441 = 0$ M1 corr subst'n or fact'n M1 $1 - p$ seen B1 $2p(1 - p) = 0.42$ or $p(1 - p) = 0.21$ M1 $p^2 - p = -0.21$ $p^2 - p + 0.25 = -0.21 + 0.25$ oe } M1 OR $(p - 0.5)^2 - 0.25 = -0.21$ oe } $(p - 0.5)^2 = 0.04$ M1 $(p - 0.5) = \pm0.02$ $p = 0.3$ or 0.7 A1
Total		**8**	
9ia	$1 / {}^1/_5$ = 5	M1 A1 2	
b	$({}^4/_5)^3 \times {}^1/_5$ $= {}^{64}/_{625}$ or 0.102 (3 sfs)	M1 A1 2	
c	$({}^4/_5)^4$ $= {}^{256}/_{625}$ or a.r.t 0.410 (3 sfs) or 0.41	M1 A1 2	or $1 - ({}^1/_5 + {}^4/_5 \times {}^1/_5 + ({}^4/_5)^2 \times {}^1/_5 + ({}^4/_5)^3 \times {}^1/_5)$ NOT $1 - ({}^4/_5)^4$
iia	$P(Y=1) = p$, $P(Y=3) = q^2p$, $P(Y=5) = q^4p$	B1 1	$P(Y=1)+P(Y=3)+P(Y=5) = p + q^2p + q^4p$ p, $p(1 - p)^2$, $p(1 - p)^4$ q^{1-1}, q^{3-1}, q^{5-1} or any of these with $1 - p$ instead of q "Always q to even power × p" Either associate each term with relevant prob Or give indication of how terms derived ≥ two terms
b	Recog that c.r. = q^2 or $(1 - p)^2$ $S_\infty = \frac{p}{1-q^2}$ or $\frac{p}{1-(1-p)^2}$ $P(\text{odd}) = \frac{1-q}{1-q^2}$ $= \frac{1-q}{(1-q)(1+q)}$ Must see this step for A1 $(= \frac{1}{1+q}$ **AG**)	M1 M1 M1 A1 4	or eg $r = q^2p/p$ $(= \frac{p}{2p-p^2}) = \frac{p}{p(2-p)}$ $(= \frac{1}{2-p}) = \frac{1}{2-(1-q)}$

4732 Probability & Statistics 1

Note: "(3 sfs)" means "answer which rounds to ... to 3 sfs". If correct ans seen to ≥ 3sfs, ISW for later rounding
Penalise over-rounding only once in paper.

1ia	5! or $^5P_5$ = 120	M1 A1 2	
b	4! or $^4P_4$ seen 4! × 2 48	M1 M1dep A1 3	or 2 × 3! or 2! × 3! or 2! × $^3P_3$ 2 × 3! × 4
ii	$^1/_5C_2$ or $^1/_5 \times ¼ \times 2$ or 0.4×0.25 or $^2/_{5P2}$ $= {}^1/_{10}$	M1 A1 2	Allow M1 for $^5C_2$ or $^1/_5$ x ¼ or $^1/_{20}$ or $^1/_5 \times {}^1/_5 \times 2$ or $^2/_{25}$ oe
Total		**7**	
2i	$(^4/_5)^3 \times (^1/_5)$ oe $= {}^{64}/_{625}$ or 0.102 (3 sfs)	M1 A1 2	Allow M1 for $(^4/_5)^4$ x $(^1/_5)$
ii	$(^4/_5)^4$ alone or $1-(^1/_5 + {}^4/_5 x\, {}^1/_5 + (^4/_5)^2 x\, {}^1/_5 + (^4/_5)^3 x\, {}^1/_5)$ $= {}^{256}/_{625}$ or 0.410 (3 sfs)	 M1 A1 2	Allow $(^4/_5)^3$ or $(^4/_5)^5$; not 1 - $(^4/_5)^4$ Allow one term omitted or wrong or "correct" extra Allow 0.41
iii	5	B1 1	
Total		**5**	
3i	$r = \dfrac{212 - \frac{24 \times 39}{5}}{\sqrt{(130 - \frac{24^2}{5})(361 - \frac{39^2}{5})}}$	B2 2	$\frac{24.8}{\sqrt{14.8 \times 56.8}}$ or $\frac{24.8}{\sqrt{840.64}}$ or $\frac{24.8}{3.85 \times 7.54}$ or $\frac{24.8}{29}$ B2 for correct subst in r B1 for correct subst in any S
ii	$R = 0.7$ or (B) Definition of r_s is PMCC for ranks	B1 B1 2	(A) and (B) true: B0B0 dep 1st B1
iii	$r = 0.855$ $r_s = 0.7$	B1 B1 2	 or "unchanged": B1B1 Interchanged: B1
Total		**6**	
4i	0.4 x p = 0.12 or $^{0.12}/_{0.4}$ or $^{12}/_{40}$ oe p = 0.3 oe	M1 A1 2	
ii	0.4 x (1 – their 0.3) oe eg $^{40}/_{100} \times {}^{28}/_{40}$ 0.28 or 28% oe	M1 A1ft 2	or 0.4 – 0.12 or 0.28 or 28 seen Not 0.4×0.88 unless ans to (i) is 0.12
Total		**4**	
5ia	Binomial stated or implied 0.9806	B1 B1 2	by use of tables or 0.2^a x 0.8^b, $a+b = 12$
b	0.5583 seen 1 – 0.5583 = 0.442 (3 sfs)	M1 M1 A1 3	add 10 corr terms or 1-(add 3 corr terms): M2 or 1– 0.7946 or 0.205 or 1-0.6774 or 0.323 or 1-0.3907 or 0.609 or add 9 terms or 1-(add 2 or 4 terms): M1
ii	$^{15}C_4$ x 0.3^4 x 0.7^{11} = 0.219 (3 sfs)	M2 A1 3	$^{15}C_4$ x 0.3^{11} x 0.7^4 : M1
Total		**8**	

6i	Σyp $= 2.3$ $\Sigma y^2 p$ (= 5.9) $- (\Sigma yp)^2$ $= 0.61$ oe	M1 A1 M1 M1 A1 5	$\geq$ 2 terms added ÷ 3 or ÷ 6 etc: M0 $\geq$ 2 terms added ÷ 3 or ÷ 6 etc: M0 dep +ve result $(-1.3)^2\times0.2+(-0.3)^2\times0.3+0.7^2\times0.5$: M2 one term correct: M1 Use of *Z*: MR, lose last A1 (2.55, 0.4475)
ii	0.2x0.25 + 0.3x0.1 or 0.05 + 0.03 alone $= 0.08$ oe	M2 A1 3	M1 for one product eg correct×2: M1 or clearly ident (1,2), (2,1): M1
iii	$0.3\times0.1 + 0.3\times0.25 + 0.3\times0.65$ $+ 0.25\times0.2 + 0.25\times0.5$ alone or 0.03 + 0.075 + 0.195 + 0.05 + 0.125 $= 0.475$ or $^{19}/_{40}$ oe	 M2 A1 3	 M1 : any 3, 4 of these prods alone or these 5 prods plus 1 extra or repeat or (ii) + prod or 0.3 + prod or 0.25 + prod or clearly identify (1,2) (3,2) (2,2) (2,1) (2,3) M2 for 0.3 + (0.2 + 0.5) × 0.25 or 0.25 + (0.1 + 0.65) × 0.3 or 0.3 + 0.25 – 0.3 × 0.25 or 1 – (0.2+ 0.5)(0.1+0.65) M1 for (0.2+ 0.5)(0.1+0.65)
Total		**11**	
7ia	Results or matches are indep Prob of winning is constant	B1 B1 2	allow "wins" indep; not "trials" indep not "success"
ib	No of wins (or losses)	B1 1	
ii	$^{21}C_{10}\, p^{10}q^{11} = {}^{21}C_9\, p^9 q^{12}$ $\frac{12}{10}\, p = q$ or $\frac{12}{10}p(1-p)^{-1} = 1$ or similar $1.2p = 1 - p$ oe eg $p = 0.833(1-p)$ or $352716p = 293930(1-p)$ $p = {}^5/_{11}$ or 0.455 (3 sfs) oe	 M1 M1M1 M1 A1 5	or $(1 - p)$ for q & allow omit bracket or $352716\, p^{10}q^{11} = 293930\, p^9 q^{12}$ M1 for $^{12}/_{10}$ or $^6/_5$ or 1.2 or $^5/_6$ or 0.833 M1 for p & q cancelled correctly or equiv equn in p or q (cancelled) nos not nec'y cancelled; not alg denom
Total		**8**	

8i	m = 26.5		B1	
	LQ = 22	or 21.5	or 21.75	
	UQ = 39	40	39.5	M1 M1 for either LQ or UQ
	IQR = 17	18.5	17.75	A1 3 A1 must be consistent LQ, UQ & IQR
ii	Ave or overall or med or "it" similar		B1f	or F med (or ave) higher or F mean less or M & F both have most in 20s
	Male spread greater or M more varied oe		B1f 2	or male range greater or more younger F or more older M
iii	Med less (or not) affected by extreme(s) or Mean (more) affected by extreme(s)		B1 1	oe; not "anomalies" ignore eg "less accurate"
iv				must consistently decode last or first
	Decode last			
	245/49		M1	
	= 5		A1	
	mean = 205		B1f	200 + "5"
	$\sqrt{(9849/49 - (^{245}/_{49})^2)}$		M1	dep √+ve
	= 13.3 (3sfs) or $4\sqrt{11}$		A1	
	sd = 13.3 or $4\sqrt{11}$		B1f 6	dep M1 or ans 176; award if not +200
	Decode first			
	245 + 200×49 or 10045	B1		
	$^{10045}/_{49}$	M1		allow $^{445}/_{49}$ or 9.08 seen
	= 205	A1		
	$\Sigma x^2 = 9849+400\times10045-49\times40000$ or 2067849	B1		
	$\sqrt{\frac{"\Sigma x^2"}{49} - "\bar{x}^2"}$	M1		dep √+ve Σx^2 must be: attempt at Σx^2 >9849 not involve 9849^2 not $(\Sigma x)^2$ eg 10045^2, 445^2 $\bar{x}$ must be decoded attempt, eg 9.08
	= 13.3 or $4\sqrt{11}$	A1		
Total			**12**	
9i	Because growth may depend on pH oe or expt is investigating if *y* depends on *x*		B1 1	In context. Not *x* is controlled or indep
ii	$S_{xy} = 17082.5 - 66.5 \times 1935/8$ (= 997.8125)			
	$S_{xx} = 558.75 - 66.5^2/8$ (= 5.96875)			
	$b = S_{xy}/S_{xx}$		M1	Correct sub into any correct *b* formula
	= 167 (3 sfs)		A1	
	$y - 1935/8 = "167"(x - 66.5/8)$		M1	or a =1935/8 – "167" x 66.5/8
	$y = -1150 + 167x$		A1 4	cao NB 3 sfs
iii	$y = -1150 + 167 \times 7$		M1	ft their eqn for M1 only
	= 19 to 23		A1 2	
iv	No (or little) relationship or correlation		B1 1	or weak or small corr'n. Not "agreement"
va	Reliable as *r* high oe		B1 1	Allow without "interpolation" oe, but must include *r* high
b	Unreliable as extrapolation oe		B1 1	or unreliable as gives a neg value
vi	Unreliable (or No) because *r* near 0 or because little (or no or small) corr'n (or rel'n)		B1 1	or No because Q values vary widely for pH = 8.5
Total			**11**	

Total 72 marks

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Note: "(3 sfs)" means "answer which rounds to ... to 3 sfs". If correct ans seen to ≥ 3sfs, ISW for later rounding
Penalise over-rounding only once in paper.

1(i)	(a) -1 (b) 0	B1 B1 2	allow ≈ -1 or close to -1 not "strong corr'n", not -0.99 allow ≈ 0 or close to 0 not "no corr'n"
(ii)	4 3 2 1 or 1 2 3 4 1 3 4 2 4 2 1 3 Σd^2 (= 14) $1 - \frac{6\Sigma d^2}{4(4^2-1)}$ = -0.4 oe	M1 A1 M1 M1 A1 5	Ranks attempted, even if opp Dep M1 or $S_{xy} = 23-{}^{100}/_{4}$ or $S_{xx} = S_{yy} = 30-{}^{100}/_{4}$ Dep 2nd M1 $S_{xy}/\sqrt{(S_{xx}S_{yy})}$
Total		**7**	
2(i)	$\frac{{}^{7}C_2 \times {}^{8}C_3}{{}^{15}C_5}$ = ${}^{56}/_{143}$ or ${}^{1176}/_{3003}$ or 0.392 (3sfs)	M1 M1 A1 3	${}^{7}C_2 \times {}^{8}C_3$ or 1176 : M1 (Any C or P)/${}^{15}C_5$: M1 (dep < 1) or $\frac{7}{15}\times\frac{6}{14}\times\frac{8}{13}\times\frac{7}{12}\times\frac{6}{11}$ or 0.0392: M1 $\times {}^{5}C_2$ or × 10 : M1 (dep ≥4 probs mult) if 2↔3, treat as MR max M1M1
(ii)	3! x 2! or ${}^{3}P_3 \times {}^{2}P_2$ not in denom = 12	M1 A1 2	BABAB seen: M1 120-12: M1A0 NB ${}^{4!}/_{2!}$ = 12: M0A0
Total		**5**	
3(i)(a)	0.9368 or 0.937	B1 1	
(b)	0.7799 – 0.5230 or ${}^{8}C_5 \times 0.45^3 \times 0.55^5$ = 0.2569 or 0.2568 or 0.257	M1 A1 2	Allow 0.9368 – 0.7799
(c)	0.7799 seen – 0.0885 (not 1 – 0.0885) = 0.691 (3 sfs)	M1 M1 A1 3	${}^{8}C_5 x 0.45^3 x 0.55^5 + {}^{8}C_4 x 0.45^4 x 0.55^4 + {}^{8}C_3 x\ 0.45^5 \times 0.55^3$: M2 1 term omitted or wrong or extra: M1
(ii)(a)	${}^{10}C_2 \times ({}^{7}/_{12})^8 \times ({}^{5}/_{12})^2$ seen = 0.105 (3 sfs)	M1 A1 2	or 0.105 seen, but not ISW for A1
(b)	$2{}^{31}/_{72}$ or ${}^{175}/_{72}$ or 2.43 (3 sfs)	B1 1	NB ${}^{12}/_{5}$ = 2.4: B0
Total		**9**	
4(i)	${}^{1}/_{20} \times {}^{1}/_{10}$ or ${}^{1}/_{200}$ or 0.005 x 2 = ${}^{1}/_{100}$ or 0.01	M1 M1dep A1 3	
(ii)	$E(X) = 0+50\times{}^{1}/_{10}+500\times{}^{1}/_{20}$ or $0+0.5\times{}^{1}/_{10}+5\times{}^{1}/_{20}$ = 30p = £0.30 or ${}^{3}/_{10}$ Charge "30p" + 20p or 0.3 + 0.2 = 50p or 0.50 or 0.5	M1 A1 M1 A1 4	or eg 20 goes: 2 × £0.50 + £5.00 = £6.00 ("£6.00" + 20 × £0.20) ÷ 20 condone muddled units eg 0.3 + 20 x = 20, 70, 520 : M1A1 $20\times{}^{17}/_{20} + 70\times{}^{1}/_{10} + 520\times{}^{1}/_{20}$: M1 = 50 A1 x, $(x-50)$, $(x-500)$: M1A1 $x\times{}^{17}/_{20}+(x-50)\times{}^{1}/_{10}+(x-500)\times{}^{1}/_{20} = 20$: M1 x = 50 : A1 Ignore "£" or "p"
Total		**7**	

5(i)	$^{12}/_{22}$ x $^{11}/_{21}$ $= {}^{2}/_{7}$ oe or 0.286 (3 sfs)	M1 A1 2	or $^{12}C_2$ / $^{22}C_2$
(ii)	$^{7}/_{15}$ x $^{6}/_{14}$ x $^{8}/_{13}$ or $^{8}/_{65}$ oe × 3 oe $= {}^{24}/_{65}$ or 0.369 (3 sfs)	M1 M1 A1 3	Numerators any order $^{7}C_2$ x $^{8}C_1$:M1 3 x prod any 3 probs (any C or P)/$^{15}C_3$:M1 (dep <1) $1-(^{8}/_{15}x^{7}/_{14}x^{6}/_{13}+3\times{}^{8}/_{15}x^{7}/_{14}x^{7}/_{13}+{}^{7}/_{15}x^{6}/_{14}x^{5}/_{13})$: M2 one prod omitted or wrong: M1
(iii)	$\frac{x}{45}\times\frac{x-1}{44}=\frac{1}{15}$ oe $x^2 - x - 132 = 0$ or $x(x - 1) = 132$ $(x - 12)(x + 11) = 0$ or $x = \frac{1 \pm \sqrt{(1^2 - 4\times(-132))}}{2}$ No. of Ys = 12	M1 A1 M1 A1 4	not $\frac{x}{45}\times\frac{x}{44}=\frac{1}{15}$ or $\frac{x}{45}\times\frac{x}{45}=\frac{1}{15}$ or $\frac{x}{45}\times\frac{x-1}{45}=\frac{1}{15}$ oe ft 3-term QE for M1 condone signs interchanged allow one sign error Not $x = 12$ or -11 ans 12 from less wking, eg $12\times11=132$ or T & I: full mks Some incorrect methods: $\frac{x}{45}\times\frac{x-1}{44}=\frac{1}{15}$ oe M1 $x^2 + x = 132$ A0 $x = 11$ M1A0 $12 \times 11 = 132$ M1A1M1 $x = 12$ and (or "or") 11 A0 NB 12 from eg 12.3 rounded, check method
Total		**9**	

6(i)(a)	256	B1 1	
			(i)(b) & (ii)(abc): ISW ie if correct seen, ignore extras
(b)	Total unknown or totals poss diff or Y13 may be smaller or similar or size of pie chart may differ	B1 1	pie chart shows only proportions oe or no. of students per degree may differ not "no. of F may be less" not "Y13 may be larger"
(ii)(a)	B&W does not show frequencies oe	B1 1	or B&W shows spread or shows mks or M lger range
(b)			1 mk about overall standard, based on median or on F's IQR being "higher" 1 mk about spread (or range or IQR) or about skewness. must be overall, not indiv mks must be comparison, not just figures Examples:
	F generally higher or median higher F higher on average or F better mks		not F higher mean
	F IQR is above M IQR	B1	
	F more compact M wide(r) range or gter IQR or gter variation or gter variance or more spread or less consistent		not M have hiest and lowest mks
	M evenly spread or F skewed	B1 2	condone F +ve skew
(c)	<u>Advantage</u>: B&W shows med or Qs or IQR or range or hiest & lowest or key values	B1	not B&W shows skewness not B&W shows info at a glance not B&W easier to compare data sets not B&W shows mean not B&W shows spread not B&W easier to calculate or easier to read
	<u>Disadvantage</u>: B&W loses info' B&W shows less info' B&W not show freqs B&W not show mode B&W: outlier can give false impression		not B&W does not give indiv (or raw) data not B&W does not show mean
	hist shows more info hist shows freqs or fds hist shows modal class (allow mode) hist shows distribution better can calc mean from hist	B1 2	not hist shows freq for each mark not hist shows all the results not hist shows total allow adv of hist as disadv of B&W
(iii)	102 x 51 + 26 x 59 ÷ 128 = 52.6 (3 sfs)	M1 M1dep A1 3	or 5202 + 1534 or 6736
Total		**10**	

7(i)	Geo stated 0.7^3 x 0.3 $^{1029}/_{10000}$ oe or 0.103 (3 sfs)	M1 M1 A1 3	or implied by 0.7^rx0.3 or 0.3^rx0.7 Allow 0.7^4 x 0.3
(ii)	0.7^6 alone = 0.118 (3 sfs)	M1 A1 2	1-(0.3+0.3×0.7+...+ 0.3×0.7^5) not 1-0.7^6
(iii)	0.7^9 $1 - 0.7^9$ 0.960 (3 sfs)	M1 M1 A1 3	not 0.3×0.7^9 allow $1 - 0.7^{10}$ or 0.972 for M1 allow 0.96, if no incorrect wking seen 0.3 + 0.7 x 0.3 + …. + 0.7^8 x 0.3: M2 1 term omitted or wrong or "correct" extra: M1
(iv)	Bin stated $^5C_2$ x 0.7^3 x 0.3^2 or 0.8369 – 0.5282 = 0.3087 or 0.309 (3 sfs)	M1 M1 A1 3	or implied by table or ^nC_r or $0.7^3 \times 0.3^2$ or 0.0309
Total		**11**	
8(i)	$\dfrac{168.6 - \dfrac{88\times16.4}{8}}{\sqrt{(1136 - \dfrac{88^2}{8})(34.52 - \dfrac{16.4^2}{8})}}$ = -0.960 (3 sfs)	M2 A1 3	$(= \dfrac{-11.8}{\sqrt{168\times0.9}})$ M1: correct subst in any correct *S* formula M2: correct substn in any correct *r* formula allow -0.96, if no incorrect wking seen
(ii)	must refer to, or imply, external constraint on *x* e.g *x* is controlled or values of *x* fixed or chosen allow *x* is fixed	B1 1	not *x* is not random not *x* affects *y* not *x* not affected by *y* not *x* goes up same amount each time not charge affects no. of vehicles not *x* not being measured
(iii)	$\dfrac{168.6 - \dfrac{88\times16.4}{8}}{1136 - \dfrac{88^2}{8}}$ = -0.0702 (3 sfs) or $-^{59}/_{840}$ or $-^{11.8}/_{168}$ $y - {}^{16.4}/_8$ = "-0.0702"($x - {}^{88}/_8$) y = -0.07x + 2.8 or better	M1 A1 M1 A1 4	ft their S_{xy} and S_{xx} incl $^{168.6}/_{1136}$ if used in (i) or -0.07 if no incorrect wking or $a = {}^{16.4}/_8 - (\text{"-0.0702"}) \times {}^{88}/_8$ or $^{2371}/_{840}$ oe eg $y = -{}^{59}/_{840}x + {}^{2371}/_{840}$
(iv)(a)	"-0.07" x 20 + "2.8" = 1.4(2) million (2 sfs)	M1 A1 2	 no ft
(b)	*r* close to -1 or corr'n is high just outside given data, so reliable	B1 B1 2	or good corr'n or pts close to line but not if "close to -1, hence unreliable" if *r* low in (i), ft: "*r* low" or "poor corr'n" etc or outside given data so unreliable not "reliable as follows trend" not "reliable as follows average" no ft from (iv)(a)
(v)	*y* on *x* *x* is indep	B1 B1 2	 or *x* controlled or *y* depends on *x* or *y* not indep dep on not "*x* on *y*" *r* close to -1 so makes little difference: B2
Total		**14**	

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Note: "(3 sfs)" means "answer which rounds to ... to 3 sfs". If correct ans seen to ≥ 3sfs, ISW for later rounding. Penalise over-rounding only once in paper.

1 (i)	$0.2^2 + 0.7 \times 0.1 \times 2$	M2	0.2^2 or 0.7×0.1: M1
	= 0.18 **AG**	A1 3	no errors seen NB $2 \times 0.9 \times 0.1 = 0.18$ M0A0
(ii)	$0.28 + 2\times0.18 + 3\times0.04 + 4\times0.01$	M1	≥ 2 terms correct (excl 0×0.49) ÷ 5 (or 4 or 10 etc): M0
	= 0.8 oe	A1	
	$0.28 + 2^2\times0.18 + 3^2\times0.04 + 4^2\times0.01$	M1	≥ 2 terms correct (excl $0^2\times0.49$)
	- "0.8"^{2}	M1	dep +ve result
	= 0.88 oe	A1 5	cao
			$\Sigma(x-\mu)^2$: 2 terms: M1; 5 terms M2
			$0.8^2\times0.49+0.2^2\times0.28+1.2^2\times0.18+2.2^2\times0.04+3.2^2\times0.01$
			SC Use original table, 0.4:B1 0.44: B1
Total		**8**	
2(i)(a)	$\dfrac{8736.9 - \dfrac{202\times245.3}{7}}{7300 - \dfrac{202^2}{7}}$ or $\dfrac{1658.24}{1470.86}$	M1	correct sub in any correct formula for b eg $\dfrac{236.8921}{210.1249}$
	= 1.127… (= 1.13 **AG**)	A1 2	must see 1.127… ; 1.127.. alone: M1A1
(b)	$y - {}^{245.3}/_{7} = 1.13(x - {}^{202}/_{7})$	M1	or $a = {}^{245.3}/_{7} - 1.13 \times {}^{202}/_{7}$
	$y = 1.1x + 2.5$ (or 2.4) or $y = 1.13x + 2.43$	A1 2	2 sfs suff. (exact: y = 1.127399..x + 2.50934…)
(ii)(a)	(1.1(..) × 30 + 2.5(..)) = 35.5 to 36.5	B1f 1	
(b)	(1.1(..) × 100 + 2.5(..)) = 112.4 to 115.6	B1f 1	
(iii)	(a) Reliable	B1	Both reliable: B1 | (a) more reliable than (b) B1 because (a) within data or (b) outside data B1
	(b) Unreliable because extrapolated	B1 2	Ignore extras
Total		**8**	
3(i)(a)	Geo stated	M1	or impl. by $({}^{7}/_{8})^n({}^{1}/_{8})$ or $({}^{1}/_{8})^n({}^{7}/_{8})$ alone
	$({}^{7}/_{8})^2({}^{1}/_{8})$	M1	
	${}^{49}/_{512}$ or 0.0957 (3 sfs)	A1 3	
(b)	$({}^{7}/_{8})^3$ alone	M2	or $1-({}^{1}/_{8}+{}^{7}/_{8}\times{}^{1}/_{8}+({}^{7}/_{8})^2\times{}^{1}/_{8})$: M2 one term incorrect, omit or extra: M1 $1-({}^{7}/_{8})^3$ or $({}^{7}/_{8})^2$ alone: M1
	${}^{343}/_{512}$ or 0.670 (3 sfs) allow 0.67	A1 3	
(ii)	8	B1 1	
(iii)	Binomial stated or implied	M1	eg by $({}^{7}/_{8})^a({}^{1}/_{8})^b$ ($a+b = 15$, $a,b \neq 1$), not just ${}^nC_r$
	${}^{15}C_2({}^{7}/_{8})^{13}({}^{1}/_{8})^2$	M1	
	= 0.289 (3 sfs)	A1 3	
Total		**10**	
4 (i)	1 2 3 4 5 or 5 4 3 2 1	M1	attempt ranks
	3 5 4 1 2 3 1 2 5 3	A1	correct ranks
	Σd^2 (= 32)	M1dep	S_{xx} or S_{yy}=55–$15^2/_5$(=10) or S_{yy}=39–$15^2/_5$(= -6)
	$1 - {}^{6\times\text{"32"}}/_{5(25-1)}$	M1dep	${}^{-6}/\sqrt{(10\times10)}$
	= - 0.6	A1 5	

(ii)	1 & 3 Largest neg r_s or large neg r_s or strong neg corr'n or close(st) to -1 or lowest r_s	B1ind B1dep 2	ft if -1 < (i) < -0.9, ans 1 & 2 NOT: furthest from 0 or closest to ±1 little corr'n most disagreement
Total		**7**	

5 (i)	68 75 – 59 = 16	B1 M1 A1 3	 attempt 6th & 18th or 58-60, 74-76 & subtr must be from 75 – 59
(ii)	Unaffected by outliers or extremes (allow less affected by outliers) sd can be skewed by one value	B1 1	NOT: … by anomalies or freaks easier to calculate
(iii)	Shows each data item, retains orig data can see how many data items can find (or easier to read) mode or modal class can find (or easier to read) frequs can find mean Harder to read med (or Qs or IQR) Doesn't show med (or Qs or IQR) B&W shows med (or Qs or IQR) B&W easier to compare meds	 B1 B1 2	NOT: shows freqs shows results more clearly B&W does not show freqs NOT: B&W easier to compare B&W shows spread or variance or skew B&W shows highest & lowest Assume in order: Adv, Disadv, unless told Allow disadv of B&W for adv of S&L & vice versa Ignore extras
(iv)	m = 68.1 NOT by restart sd = 9.7 (or same) NOT by restart	B1 B1 2	 Restart mean or mean & sd: 68.1 or 68.087 & 9.7 or 9.73 B1 only
Total		**8**	

6 (i) (a)	8! = 40320	M1 A1 2	Allow $^4P_4$ & $^3P_3$ instead of 3! & 4! thro'out Q6
(b)	$^4/_8 \times {}^4/_7 \times {}^3/_6 \times {}^3/_5 \times {}^2/_4 \times {}^2/_3 \times {}^1/_2$ $\times 2$ $= {}^1/_{35}$ or 0.0286 (3 sfs)	M1 M1dep A1 3	$4! \times 4! \div 8!$ | $4! \times 4! + 4! \times 4!$ $\times 2$ | $\div 8!$ allow 1 – above for M1 only oe, eg $^{1152}/_{40320}$
(ii)(a)	$4! \times 4!$ = 576	M1 A1 2	allow $4! \times 4! \times 2$: M1
(b)	$^1/_{16}$ or 0.0625	B1 1	
(c)	Separated by 5 or 6 qus stated or illus $^1/_4 \times {}^1/_4 \times 3$ or $^1/_{16} \times 3$ ($^1/_4 \times {}^1/_4$ or $^1/_{16}$ alone or ×(2 or 6): M1) $^3/_{16}$ or 0.1875 or 0.188	M1 M2 A1 4	allow 5 only or 6 only or (4, 5 or 6) can be impl by next M2 or M1 $3! \times 3! \times 3$ ($3! \times 3!$ alone or ×(2 or 6); or $(3! + 3!) \times 3$: M1) (÷ 576) correct ans, but clearly B, J sep by 4: M0M2A0 1- P(sep by 0, 1, 2, 3, (4)) M1 $1-(^1/_4+{}^1/_4+{}^1/_4\times{}^3/_4+{}^1/_4\times{}^1/_2)$ or $1-(^1/_4\times{}^1/_4+{}^1/_2\times{}^1/_4+{}^3/_4\times{}^1/_4+1\times{}^1/_4+{}^3/_4\times{}^1/_4)$ M2 (one omit: M1)
Total		**12**	

7 (i)	Binomial $n = 12$, $p = 0.1$ Plates (or seconds) independent oe Prob of fault same for each plate oe	B1 B1 B1 B1 4	 B(12, 0.1) : B2 NOT: batches indep Comments must be in context Ignore incorrect or irrelevant
(ii)(a)	$0.9744 - 0.8891$ or $^{12}C_3 \times 0.9^9 \times 0.1^3$ = 0.0852 or 0.0853 (3 sfs)	M1 A1 2	
(b)	$1 - 0.2824$ or $1 - 0.9^{12}$ =0.718 (3 sfs)	M1 A1 2	allow $1 - 0.6590$ or $1 - 0.9^{11}$
(iii)	"0.718" and 1 – "0.718" used $(1-0.718)^4 + 4(1-0.718)^3 \times 0.718$ $+ {}^4C_2(1-0.718)^2 \times 0.718^2$ = 0.317 (3 sfs)	B1 M2 A1 4	ft (b) for B1M1M1 M1 for any one term correct (eg opp tail or no coeffs) 1 – P(3 or 4) follow similar scheme M2 or M1 1 – correct wking (= 0.623) B1M2 cao
Total		**12**	

8 (i)	$^1/_6 + 3 \times (^1/_6)^2$ $= {}^1/_4$	M2 A1 3	or $3 \times (^1/_6)^2$ or $^1/_6 + (^1/_6)^2$ or $^1/_6 + 2(^1/_6)^2$ or $^1/_6 + 4(^1/_6)^2$ M1
(ii)	$^1/_3$	B1 1	
(iii)	3 routes clearly implied out of 18 possible (equiprobable) routes $^1/_6$	M1 M1 A1 3	or $^1/_3 \times {}^1/_6 \times 3$ M2 or $^1/_3 \times {}^1/_6$ or $^1/_6 \times {}^1/_6 \times 3$ or $^1/_3 \times {}^1/_3 \times 3$ or $^1/_4 - {}^1/_6$ M1 but $^1/_6 \times {}^1/_6 \times 2$ M0 $\frac{(\frac{1}{6})^2 \times 3}{\frac{1}{2}}$ or $\frac{\frac{1}{4}-\frac{1}{6}}{\frac{1}{2}}$ or $\frac{\frac{1}{2}\times\frac{1}{6}}{\frac{1}{2}}$ oe M2 or $\frac{\text{P(4\&twice)}}{\text{P(twice)}}$ stated or $\frac{\text{prob}}{\frac{1}{2}}$ M1 Whatever 1st, only one possibility on 2nd M2 $^1/_6$, no wking M1M1A1 $^1/_{12}$, no wking M0
Total		**7**	

Total 72 marks

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1			Q1: if consistent "0.8" incorrect or $^1/_8$, $^7/_8$ or 0.02 allow M marks in ii , iii & 1st M1 in i
i	Binomial stated 0.9437 – 0.7969 or $^8C_3\times0.2^3\times0.8^5$ = 0.147 (3 sfs)	M1 M1 A1 3	or implied by use of tables or $^8C_3$ or $0.2^a\times0.8^b$ $(a+b = 8)$
ii	1– 0.7969 = 0.203 (3 sf)	M1 A1 2	allow 1– 0.9437 or 0.056(3) or equiv using formula
iii	8 × 0.2 oe 1.6	M1 A1 2	8 × 0.2 = 2 M1A0 1.6 ÷ 8 or $^1/_{1.6}$ M0A0
Total		**7**	
2	first two d's = ±1 Σd^2 attempted (= 2) $1-\frac{6\times\text{"2"}}{7(7^2-1)}$ = $^{27}/_{28}$ or 0.964 (3 sfs)	B1 M1 M1dep A1	S_{xx} or S_{yy} = 28 B1 S_{xy} = 27 B1 $S_{xy}/\sqrt{(S_{xx}S_{yy})}$ M1 dep B1 1234567 & 1276543 (ans $^2/_7$): MR, lose A1
Total		**4**	
3 i	x independent or controlled or changed Value of y was measured for each x x not dependent	B1 1	Allow Water affects yield, or yield is dependent or yield not control water supply Not just y is dependent Not x goes up in equal intervals Not x is fixed
ii	(line given by) minimum sum of squs	B1 B1 2	B1 for "minimum" or "least squares" with inadequate or no explanation
iii	S_{xx} = 17.5 or 2.92 S_{yy} = 41.3 or 6.89 S_{xy} = 25 or 4.17 $r=\frac{S_{xy}}{\sqrt{(S_{xx}S_{yy})}}$ = 0.930 (3 sf)	 B1 M1 A1 3	or $91-21^2/_6$ or $394-46^2/_6$ B1 for any one or $186-{}^{21\times46}/_6$ dep B1 0.929 or 0.93 with or without wking B1M1A0 **SC** incorrect n: max B1M1A0
iv	Near 1 or lg, high, strong, good corr'n or relnship oe Close to st line or line good fit	B1ft B1 2	$\|r\|$ small: allow little (or no) corr'n oe Not line accurate. Not fits trend
Total		**8**	

4			Q4: if consistent "0.7" incorrect or $^1/_3$, $^2/_3$ or 0.03 allow M marks in ii , iii & 1st M1 in i
i	Geo stated $0.7^3 \times 0.3$ alone $^{1029}/_{10000}$ or 0.103 (3 sf)	M1 M1 A1 3	or implied by $q^n \times p$ alone ($n > 1$) $0.7^3 - 0.7^4$
ii	0.7^4 alone $= {}^{2401}/_{10000}$ or 0.240 (3 sf)	M1 A1 2	$1 - (0.3 + 0.7\times0.3 + 0.7^2\times0.3 + 0.7^3\times0.3)$ NB $1 - 0.7^4$: M0
iii	$1 - 0.7^5$ = 0.832 (3 sfs)	M2 A1 3	or $0.3 + 0.7\times0.3 + + \ldots + 0.7^4\times0.3$ M2 M1 for one term extra or omitted or wrong or for 1– (above) M1 for $1 - 0.7^6$ or 0.7^5 NB Beware: $1 - 0.7^6 = 0.882$
		8	
5i	$^{25}/_{10}$ = 2.5	M1 A1 2	Allow $^{25}/_{(9\text{to}10)}$ or 2.78: M1
ii	(19.5, 25) (9.5, 0)	B1 B1 2	 Allow (24.5, 47) Both reversed: SC B1 If three given, ignore (24.5, 47)
iii	Don't know exact or specific values of x (or min or max or quartiles or median or whiskers). oe Can only estimate (min or max or quartiles or median or whiskers) oe Can't work out (…..) oe Data is grouped oe	 B1 1	Exact data not known Allow because data is rounded
Total		**5**	

6i	$\Sigma x \div 11$ 70 Σx^2 attempted $\sqrt{\frac{\sum x^2}{11} - \bar{x}^2}$ $= \sqrt{(^{54210}/_{11} - 70^2)}$ or $\sqrt{28.18}$ or 5.309 (= 5.31) **AG**	M1 A1 M1 A1 4	$\geq$ 5 terms, or $\sum(x-\bar{x})^2$ or $\sqrt{\frac{\sum(x-\bar{x})^2}{11}}$ $= \sqrt{^{310}/_{11}}$ or $\sqrt{28.18}$ ie correct substn or result If $\times\ ^{11}/_{10}$: M1A1M1A0
ii	Attempt arrange in order med = 67 74 and 66 IQR = 8	M1 A1 M1 A1 4	or (72.5 – 76.5) – (65.5 – 66.5) incl must be from 74 – 66
			iii, iv & v: ignore extras
iii	no (or fewer) extremes this year oe sd takes account of all values sd affected by extremes less spread tho' middle 50% same less spread tho' 3rd & 9th same or same gap	B1 1	fewer high &/or low scores highest score(s) less than last year Not less spread or more consistent Not range less
iv	sd measures spread or variation or consistency oe	B1 1	sd less means spread is less oe or marks are closer together oe
v	more consistent, more similar, closer together, nearer to mean less spread	B1 1	allow less variance Not range less Not highest & lowest closer
Total		**11**	
7i	$^8C_3$ = 56	M1 A1 2	
ii	$^7C_2$ or or $^7P_2$ / $^8P_3$ $\div(^8C_3$ or "56") only $= {}^3/_8$	$^1/_8$ not from incorrect $\times$ 3 only or $^1/_8 + {}^7/_8 \times {}^1/_7 + {}^7/_8 \times {}^6/_7 \times {}^1/_6$	M1 M1 A1 3	$^8C_1 + {}^7C_1 + {}^6C_1$ or 21 or $8\times7\times6$ or $^{¨}/_8 \times {}^{¨}/_7 \times {}^{¨}/_6$ indep, dep ans < 1	$^7/_8 \times {}^6/_7 \times {}^5/_6$ 1 – prod 3 probs
iii	$^8P_3$ or $8\times7\times6$ or $^8C_1 \times {}^7C_1 \times {}^6C_1$ or 336 $1 \div {}^8P_3$ only $= {}^1/_{336}$ or 0.00298 (3 sf)	M1 M1 A1 3	$^1/_8 \times {}^1/_7 \times {}^1/_6$ only M2 If $\times$ or $\div$: M1 $(^1/_8)^3$ M1	
Total		**8**	

8ia	$^{18}/_{19}$ or $^{1}/_{19}$ seen $^{17}/_{18}$ or $^{1}/_{18}$ seen structure correct ie 6 branches all correct incl. probs and W & R	B1 B1 B1 B1 4	 regardless of probs & labels (or 14 branches with correct 0s & 1s)
b	$^{1}/_{20} + {}^{19}/_{20} \times {}^{1}/_{19} + {}^{19}/_{20} \times {}^{18}/_{19} \times {}^{1}/_{18}$ $= {}^{3}/_{20}$	M2 A1 3	M1 any 2 correct terms added $^{19}/_{20}\times{}^{18}/_{19}\times{}^{17}/_{18}$ $1 - {}^{19}/_{20}\times{}^{18}/_{19}\times{}^{17}/_{18}$
iia	$^{19}/_{20} \times {}^{18}/_{19}$ $= {}^{9}/_{10}$ oe	M1 A1 2	$^{19}/_{20}\times{}^{18}/_{19}\times{}^{1}/_{18}+{}^{19}/_{20}\times{}^{18}/_{19}\times{}^{17}/_{18}$ or $^{1}/_{20}+{}^{17}/_{20}$
b	(P(X = 1) = $^{1}/_{20}$) $^{19}/_{20} \times {}^{1}/_{19}$ $= {}^{1}/_{20}$ Σxp $= {}^{57}/_{20}$ or 2.85	 M1 A1 M1 A1 4	 or $1 - ({}^{1}/_{20} + {}^{9}/_{10})$ or 2 probs of $^{1}/_{20}$ M1A1 $\geq$ 2 terms, ft their p's if $\Sigma p = 1$ NB: $^{19}/_{20}\times 3 = 2.85$ no mks
			With replacement:
ia			Original scheme
ib			$^{1}/_{20} + {}^{19}/_{20} \times {}^{1}/_{20} + ({}^{19}/_{20})^2 \times {}^{1}/_{20}$ or $1 - ({}^{19}/_{20})^2$ M1
iia			$({}^{19}/_{20})^2$ or $({}^{19}/_{20})^2\times{}^{1}/_{20} + ({}^{19}/_{20})^2\times{}^{19}/_{20}$ M1
b			Original scheme But NB ans 2.85(25…) M1A0M1A0
Total		**13**	

9i	$(1 - 0.12)^n$ $\underline{\log 0.05}$ $\log 0.88$ $n = 24$	 or $0.88^{23} = 0.052...$ or $0.88^{24} = 0.046...$	M1 M1 A1 3	Can be implied by 2nd M1 allow $n - 1$ or $\log_{0.88}0.05$ or 23.4(…) Ignore incorrect inequ or equals signs
ii	${}^6C_2 \times 0.88^4 \times 0.12^2$ $\times 0.12$ $= 0.0155$	(= 0.1295…)	M3 M1 A1 5	or $0.88^4 \times 0.12^2$ M2 or ${}^6C_2 \times 0.88^4 \times 0.12^2$ + extra M2 or 2 successes in 6 trials implied or ${}^6C_2$ M1 dep $\geq$ M1 $0.88^4 \times 0.12^2 \times 0.12$: M2M1 $0.88^4 \times 0.12^3$ M0M0A0 unless clear P(2 success in 6 trials) × 0.12 in which case M2M1A0
Total			**8**	

Total 72 marks

4732 Probability & Statistics 1

Note: "(3 sfs)" means "answer which rounds to ... to 3 sfs". If correct ans seen to ≥ 3sfs, ISW for later rounding
Penalise over-rounding only once in paper.

1 (i)	attempts at threading indep prob of succeeding in threading const	B1 B1 2	in context in context
(ii) (a)	$0.7^4 \times 0.3$ = 0.0720 (3sf)	M1 A1 2	 Condone 0.072
(b)	0.7^5 = 0.168 (3 sfs)	M2 A1 3	or 1-(0.3+0.7×0.3+0.7^2×0.3+0.7^3×0.3 +0.7^4×0.3) M1 for one term omitted or extra or wrong or 1-0.7^5 or(0.3+...+0.7^4×0.3) or 0.3, 0.7 muddle or 0.7^4 or 0.7^6 alone. 0.6 not 0.7 M0 in **(a)** M1 in **(b)** 1/3,2/3 used M1in **(a)** M1 in **(b)**
(iii)	likely to improve with practice hence independence unlikely or prob will increase each time	B1 B1 2	or thread strands gradually separate 1st B1 must be in context. hence independence unlikely or prob will decrease each time or similar Allow 'change'
Total		**[9]**	
2 (i) (a)	Use of correct midpts $\Sigma lf \div \Sigma f$ (= 706 ÷ 40) = 17.65 $\Sigma l^2 f$ (= 13050.5) $\sqrt{\frac{"13050.5"}{40} - "17.65"^2}$ (= √14.74) = 3.84 (3 sfs)	B1 M1 A1 M1 M1 A1 6	11,14,18,25.5 l within class, ≥ three lf seen [17.575,17.7] ≥ three l^2f seen ÷40,-mean²,√.Dep>0. ∑(l-17.65)²f, at least 3 M1,÷40,√ M1,3.84 A1. ÷ 4 ⇒ max B1M0A0M1M0A0
(b)	mid pts used or data grouped or exact values unknown oe	 B1 1	not "orig values were guesses"
(ii)	20 ÷ 5 = 4	M1 A1 2	condone 20 ÷ [4,5] or ans 5
(iii)	20.5th value requ'd and 1st two classes contain 14 values 16 – 20	 M1 B1 2	condone 20th oe or third class oe
(iv) (a)	increase	B1 1	
(b)	decrease	B1 1	
Total		**[13]**	
3 (i)	S_{hm} = 0.2412 S_{hh} = 0.10992 S_{mm} = 27.212 $r = \frac{S_{hm}}{\sqrt{(S_{hh}S_{mm})}}$ = 0.139 (3 sfs)	 B1 M1 A1 3	Allow x or ÷ 5 any one S correct ft their Ss
(ii)	Small, low or not close to 1 or close to 0 oe pts not close to line oe	B1 ft B1	1st B1 about value of r 2nd B1 about diag
(iii)	none or unchanged or "0.139" oe	B1 1	
(iv)	Larger oe	B1 1	
Total		**[7]**	

4 (i)	$(0\times\frac{1}{2})+1\times\frac{1}{4}+2\times\frac{1}{8}+3\times\frac{1}{8}$ $=\frac{7}{8}$ or 0.875 oe $(0\times\frac{1}{2})+1\times\frac{1}{4}+2^2\times\frac{1}{8}+3^2\times\frac{1}{8}$ (= $1\frac{7}{8}$) $-(\text{“}\frac{7}{8}\text{”})^2$ $=\frac{71}{64}$ or 1.11 (3 sfs) oe	M1 A1 M1 M1 A1 5	$\geq$ 2 non-zero terms seen If ÷3 or 4 M0M0M1(poss) $\geq$ 2 non-zero terms seen dep +ve result M1 all4 $(x-0.875)^2$ terms seen. M1 mult p,$\sum$ A1 1.11
(ii)	Bin stated or implied 0.922 (3 sfs)	M1 A1 2	Eg table or $\frac{1}{4}^n\times\frac{3}{4}^m$ ($n+m=10$,n,m$\neq$ 1) or10C4 or 5(or 4 or 6) terms correct
(iii)	$n = 10$ & $p = \frac{1}{8}$ stated or implied ${}^{10}C_4\times\frac{7}{8}^6\times\frac{1}{8}^4$ = 0.0230 (3 sfs)	M1 M1 A1 3	condone 0.023
Total		**[10]**	
5 (i)	$\frac{6}{14}\times\frac{5}{13}\times\frac{3}{12}$ × 3! oe $=\frac{45}{182}$ or 0.247 (3 sfs)oe	M1 M1 A1 3	${}^6C_1\times{}^5C_1\times{}^3C_1$ $\div{}^{14}C_3$ With repl M0M1A0
(ii)	$\frac{6}{14}\times\frac{5}{13}\times\frac{4}{12}+\frac{5}{14}\times\frac{4}{13}\times\frac{3}{12}+\frac{3}{14}\times\frac{2}{13}\times\frac{1}{12}$ $=\frac{31}{364}$ or 0.0852 (3 sf)	M2 A1 3	${}^6C_3+{}^5C_3+{}^3C_3$ M1 for any one $(\div{}^{14}C_3)$M1 all 9 numerators correct. With repl M1$(6/14)^3+(5/14)^3+(3/14)^3$
Total		**[6]**	
6 (a)	A: diag or explanation showing pts close to st line, always increasing B:Diag or expl based on r=1=>pts on st line =>r(s)=1	B1 B1 B1 3	. Diag or expl based on r(s)$\neq$ 1=>pts not on st line =>r$\neq$ 1 r=1=>pts on st line&r(s)$\neq$ 1=>pts not on st line B1B1 r=1=>r(s)=1 B2
(b)	$\bar{y}$ = 2.4 × 4.5 + 3.7 = 14.5 4.5 = 0.4 × “14.5”- c c = 1.3 a’=x-b’y :-14.5 M1A1; then a’=4.5-0.4x14.5=-1.3 M1A1	M1 A1 M1 A1 4	Attempt to sub expression for y x=0.96x+1.48-c oe sub x=4.5 and solve c=1.3 14.5 M1A1.(y-3.7)/2.4=0.4y-c and sub14.5 M1 c=1.3 A1
Total		**[7]**	
7 (i)	$^{25}/_{37}$	B2 2	B1 num, B1 denom 25/37xp B1
(ii)	$\frac{15}{23}$ seen or implied $\times\frac{39}{59}$ seen or implied $=\frac{585}{1357}$ or 0.431 (3 sfs) oe	M1 M2 A1 4	M1 num, M1 denom Allow M1 for 39/59x or + wrong p
Total		**[6]**	

8 (i)	$^{5!}/_{2}$ = 60	M1 A1 2	Allow 5P3
(ii)	4! = 24	M1 A1 2	Allow 2×4!
(iii)	$^{2}/_{5} \times {}^{3}/_{4}$ or3/5×2/4 × 2 = $^{3}/_{5}$ oe	M1 M1 A1 3	allow M1 for $^{2}/_{5} \times {}^{3}/_{5} \times 2$ or $^{12}/_{25}$ or (6×3!)÷**(i)** M2 or 3!÷**(i),**6÷**(i)**,(6+6)÷**(i)**,6k÷**(i)** or 6×6 or 36 or 1-correct answer M1 (k,integer ≤ 5)
Total		**[7]**	
9 (i)	p^2	B1 1	
(ii)	$(q^2p)^2$ oe =AG	B1 1	
(iii)	$r=q^2$ a/(1-r) used $(S_\infty =)\ \frac{p^2}{1-q^2}$ $= \frac{p^2}{1-(1-p)^2}$ p/(2-p) AG	B1 M1 A1 M1 A1 5	May be implied With $a=p^2$and $r=q^2$or q^4 Attempt to simplify using p+q=1 correctly. Dep on $r = q^2$ or q^4 $\frac{(1-q)^2}{(1-q)(1+q)}$ or $p^2/p(1+q)$ Correctly obtain given answer showing at least one intermediate step.
P2Total		**[7]**	

Total 72 marks

Note: "(3 sfs)" means "answer which rounds to ... to 3 sfs". If correct ans seen to ≥ 3sfs, ISW for later rounding
Penalise over-rounding only once in paper.

1i	590	B1 1	Allow approximately 590
ii	Graph horiz (for ≥ 55 mks) oe	B1 1	or levels off, or grad = 0, grad not increase Allow line not rise, goes flat, plateaus, stops increasing, not increase, doesn't move
iii	39 to 41	B1 1	
iv	Attempt read cf at 26 or 27 Double & attempt read x Max C = 29 to 31.5	M1 M1 A1 3	eg 26 mks → 150th 27 mks → 180th eg read at cf = 300 or 360 Indep of first M1 May be implied by ans Answer within range, no working, M1M1A1 32 without working, sc B1
v	LQ = 25.5-26.5 or UQ = 34-35.5 IQR = 8-10 (German) more spread	M1 A1 B1ft 3	M1 for one correct quartile dep ≥ 1 correct quartile or no working or less consistent, less uniform, less similar, more varied, more variable, greater variance, more spaced apart, further apart ft their IQR; must be consistent with IQR Correct comment with no working: M0A0B1
Total		**9**	
2i	Opposite orders or ranks or scores or results or marks $r_s = -1$	 B1 1	or reversed, or backwards, or inverse or as one increases the other decreases Needs reason AND value
ii	Attempt Σd^2 (= 6) $1 - \frac{6\times\Sigma d^2}{3(3^2-1)}$ $= -\frac{1}{2}$ oe	M1 M1 A1 3	 dep 1st M1 Allow use wrong table for M1M1
iii	3! or ${}^3P_3$ or 6 1 ÷ their '6' $\frac{1}{6}$ oe eg $\frac{6}{36}$	M1 M1 A1 3	r attempt list possible orders of 1,2,3 (≥3 orders) 2nd M1 for fully correct method only or $\frac{1}{3}\times\frac{1}{2}(\times 1)$: M1M1
Total		**7**	
3i	If x is contr (or indep) or y depend't, use y on x If neither variable contr'd (or indep) AND want est y from x: use y on x	B1 B1 2	Allow x increases constantly, is predetermined, you choose x, you set x, x is fixed, x is chosen Allow y not controlled AND want est y from x Ignore incorrect comments
iia	$S_{xx} = 510000 - \frac{1800^2}{9}$ (= 150000) $S_{xy} = 4080 - \frac{1800\times 14.4}{9}$ (= 1200) $b = \frac{'1200'}{'150000'}$ (= 0.008) $y - \frac{14.4}{9} = 0.008(x - \frac{1800}{9})$ $y = 0.008x$ (+ 0)	 M1 M1 M1 A1 4	or $\frac{510000}{9} - 200^2$ (= 16666.7) or $\frac{4080}{9}$ - 200×1.6 (= 133.33) M1 for either S $b = \frac{'133.33'}{'16666.7'}$ dep correct expressions both S's or $a = \frac{14.4}{9} - 0.008 \times \frac{1800}{9}$ (= 0) Must be all correct for M1 CAO
iib	312.5 or 313	B1ft 1	ft their equn in (iia)
iic	–0.4	B1ft 1	ft their equn in (iia)

iid	Contraction oe	B1(ft)	or length decreased, shorter, pushed in, shrunk, smaller
	Unreliable because extrapolated oe	B1 2	or not in the range of x or not in range of previous results
Total		**10**	
4ia	0.299 (3 sf)	B1 1	
ib	0.2991 – 0.1040 = 0.195 (3 sf) or $\frac{1280}{6561}$ oe	M1 A1 2	Must subtract correct pair from table
iia	${}^{15}C_4\times(1-0.22)^{11}\times0.22^4$ = 0.208 (3 sf)	M1 A1 2	Allow M1 for ${}^{15}C_4\times0.88^{11}\times0.22^4$
iib	(15 × 0.22 =) 3.3 15×0.22×(1–0.22) or '3.3'×(1–0.22) = 2.57 (3 sf)	B1 M1 A1 3	Allow M1 for 15 × 0.22 × 0.88
Total		**8**	
5i	$\frac{1}{2}\times\frac{1}{3}$ or $\frac{2}{4}\times\frac{1}{3}$ or $\frac{1}{{}^4C_2}$ or $\frac{2}{12}$ (= $\frac{1}{6}$ **AG**)	B1	or 1 out of 6 or 2 out of 12 or $\frac{2!}{4!}\times2$
	$\frac{1}{4}\times\frac{2}{3}$ or $2\times\frac{1}{4}\times\frac{1}{3}$ or $\frac{1}{2}\times\frac{1}{3}$ or $\frac{2}{4}\times\frac{1}{3}$	B1	or $\frac{2}{12}$ or $\frac{1}{6}$ or $\frac{1}{3!}$ or $\frac{1}{{}^4C_2}$ or $\frac{2!}{4!}\times2$
	Add two of these or double one (= $\frac{1}{3}$ **AG**)	B1 3	
			or $\frac{2}{{}^4C_2}$ or $4\times\frac{1}{4}\times\frac{1}{3}$ or $\frac{2}{4}\times\frac{2}{3}$ or $\frac{4}{12}$ or $\frac{2!}{4!}\times4$ B1B1
			or $\frac{2}{6}$ or $2\times\frac{1}{6}$ or $\frac{2}{3!}$ or $\frac{2!}{3!}$ B1B1
ii	X = 3, 4, 5, 6 only, stated or used	B1	Allow repetitions Allow other values with zero probabilities.
	P(X =5) wking as for P(X =4) above or 1 – ("$\frac{1}{6}$" + $\frac{1}{3}$ + $\frac{1}{6}$) or $\frac{1}{3}$	M1	
	P(X =3) wking as for P(X =6) above or 1 – ($\frac{1}{3}$ + "$\frac{1}{3}$" + $\frac{1}{6}$) or $\frac{1}{6}$	M1	or M1 for total of their probs = 1, dep B1
	3 4 5 6 $\frac{1}{6}$ $\frac{1}{3}$ $\frac{1}{3}$ $\frac{1}{6}$ oe	A1 4	or P(X =3)= $\frac{1}{6}$, P(X = 4)= $\frac{1}{3}$, P(X = 5)= $\frac{1}{3}$, P(X = 6)= $\frac{1}{6}$ Complete list of values linked to probs
iii	Σxp = $4\frac{1}{2}$	M1 A1	$\geq$ 2 terms correct ft
	Σx^2p (= $21\frac{1}{6}$) – '$4\frac{1}{2}$'^{2} = $\frac{11}{12}$ or 0.917 (3 sf)	M1 M1 A1 5	$\geq$ 2 terms correct ft Independent except dependent on +ve result
Total		**12**	

6	$m = (9 \times 6 + 3) \div 10$ $= 5.7$	M1 A1	or ((Sum of any 9 nos totalling 54) + 3) ÷ 10
	$2 = \frac{\Sigma x^2}{9} - 6^2$	M1	or $\frac{\Sigma(x-6)^2}{9} = 2$ M1
	$\Sigma x^2 = 2\times9 + 6^2\times9$ or 342	A1	or $\Sigma x^2 = 18 + 12\times54 - 36\times9$ or 342 A1
	$v = \frac{('342' + 3^2)}{10} - '5.7'^2$	M1	dep Σx^2 attempted, eg $(\Sigma x)^2$ (= 3249) or just state 'Σx^2'; allow √
	= 2.61 oe	A1 6	CAO
Total		**6**	
7i	${}^4C_2 \times {}^6C_3 \times {}^5C_4$ or $6\times20\times5$ = 600	M1M1 A1 3	M1 for any 2 correct combs seen, even if added
ii	$\frac{2}{4}$ or $\frac{{}^3C_1}{{}^4C_2}$ or $\frac{{}^3C_1\times{}^6C_3\times{}^5C_4}{{}^4C_2\times{}^6C_3\times{}^5C_4}$ or $\frac{{}^3C_1\times{}^6C_3\times{}^5C_4}{'600'}$ = $\frac{1}{2}$ oe	M1 A1 2	or $\frac{1}{4}\times1 + \frac{3}{4}\times\frac{1}{3}$ or $\frac{1}{4}\times2$ or $\frac{1}{4}+\frac{1}{4}$
iii	${}^3C_1 \times {}^6C_3$ (× ${}^4C_4$) + ${}^3C_2 \times {}^6C_3 \times {}^5C_4$ 360	M1M1 A1 3	M1 either product seen, even if × or ÷ by something
Total		**8**	

8			
8ia	Geo(0.3) stated or implied $0.7^3 \times 0.3$ = 0.103 (3 sf)	M1 M1 A1 3	by $0.7^n \times 0.3$
b	0.7^3 or 0.343 $1 - 0.7^3$ = 0.657	M1 M1 A1 3	0.7^3 must be alone, ie not $0.7^3 \times 0.3$ or similar allow $1 - 0.7^4$ or 0.7599 or 0.76 for M1 only or $0.3 + 0.7\times0.3 + 0.7^2\times0.3$: M1M1 1 term wrong or omitted or extra M1 or $1 - (0.3 + 0.7\times0.3 + 0.7^2\times0.3)$ or 0.343: M1
iia	State or imply one viewer in 1st four $^4C_1 \times 0.7^3 \times 0.3$ (= 0.412) $\times 0.3$ = 0.123 (3 sf)	M1 M1 M1 A1 4	or B(4, 0.3) stated, or $^4C_1$ used, or YNNNY dep 1st M1
b	$0.7^5 + {}^5C_1 \times 0.7^4 \times 0.3$ = 0.528 (3 sf)	M1 A1 2	or $1 - (0.3^2 + 2\times0.3^2\times0.7 + 3\times0.3^2\times0.7^2 + 4\times0.3^2\times0.7)$ Not ISW, eg 1 – 0.528: M1A0
Total		**12**	

Total 72 marks

Note: "(3 sfs)" means "answer which rounds to ... to 3 sfs". If correct ans seen to ≥ 3sfs, ISW for later rounding
Penalise over-rounding only once in paper.

1i	38 61	B1 B1 2	Reversed: B1B0	
ii	Paper 2 Higher median or curve is to right	B1 B1dep 2	Indep of reason or similar Higher average or mean or midpoint Paper 2: half ≤ 61, cf paper 1: half ≤ 38 Paper 1: more students scored lower marks (or lower than eg 40)	Ans "Paper 1", ignore reason: B0B0 unless reversed in (i) More scored higher mks Highest & lowest mks are higher For each cf, the corresponding mark is higher in p2. None get 0-10 Some get 100 Eg 25 scored > 69 in p1, cf 65 scored > 69 in p2 NOT Marks are higher NOT marks seem higher NOT everyone gets higher mks NOT Curve steeper Ignore irrelevant or incorrect SC: If reversed in (i): (ii) p1 because median higher B1B1ft
iii	55, 25 73, 46 Paper 1 IQR = 30 Paper 2 IQR = 27 Suggestion correct or p2 less varied	M1 A1 A1 B1f indep 4	M1 one pair of quartiles p2 more consistent or less spread out Allow "p2 has smaller range (or smaller variance") if IQRs found "It" is less varied: assume p2: B1	Allow 55±1, 25±1 Not necessarily subtracted 73±1, 46±1 30±1 27±1 p1 more varied or more spread out or less consistent Little difference or similarly varied NOT p2 IQR smaller than p1 unless also says less varied oe If quartiles found but not IQRs: max M1A0A0B1 If no quartiles calculated can still score B1 Steeper curve alone M0A0A0B0 If IQRs wrong, with p1 < p2, ft "suggestion wrong": B1f Ignore irrelevant or incorrect

iv	37 (± 3)	B2 2	B1 for 163 (± 3)	Not necessarily integer. B1 for 78-80 mks for min grade A on p2 SC: ans 105 – 110: B1 (from p1 10 mks hier instead of lower)
v	37.5 28.2	B1 B1 2	cao or sd the same	NOT eg 37.51 Ignore all working
Total		**12**		
2				SC:Consistent use of incorrect (1 – 0.2) score M-marks only SC:Consistent 0.8 insted of 0.2, no A-marks: max M0M2M2M2 "Consistent" means in every part attempted
2i	$0.8^2\times0.2$ $= \frac{16}{125}$ or 0.128	M1 A1 2		
ii	$0.8^2\times0.2 + 0.8^3\times0.2 + 0.8^4\times0.2$ $= \frac{976}{3125}$ or 0.312 (3 sfs)	M2 A1 3	1 term omitted or wrong or extra: M1	Using P($X\leq5$) & P($X\leq2$); three methods: $1 - 0.8^5 - (1-0.8^2)$ or 0.672 – 0.36: M2 Allow M1 for $1 - 0.8^5 - (1-0.8^3)$ or 0.672 – 0.488 or $1 - 0.8^4 - (1-0.8^2)$ or 0.5904 – 0.36 $0.8^2 - 0.8^5$: M2 Allow M1 for $0.8^3 - 0.8^5$ or $0.8^2 - 0.8^4$ $0.2+0.8\times0.2+0.8^2\times0.2+0.8^3\times0.2+0.8^4\times0.2 - (0.2+0.8\times0.2)$: M2 One term omitted or wrong or extra: M1 But NB If include $0.8^{-1}\times0.2$ in both P($X\leq5$) & P($X\leq2$), get correct ans but M1M0A0 M0 for eg $1 - 0.8^5 - 0.8^2$ or 0.672 – 0.64
iii	0.8^4 $= \frac{256}{625}$ or 0.4096 or 0.410 (3 sfs)	M2 A1 3	$1-(0.2 + 0.8\times0.2 + 0.8^2\times0.2 + 0.8^3\times0.2)$ 1 term omitted or wrong or extra: M1 $1 - 0.8^4$ or 0.590 M1 or 0.8^3 or 0.512 or 0.8^5 or 0.328: M1 Allow 0.41	$1 - (0.2 + 0.8\times0.2 + 0.8^2\times0.2 + 0.8^3\times0.2)$ M2 0.2×0.8^4 M0 $1 - 0.8^n$ ($n \neq 4$) M0

iv	$0.2 \times 0.8 \times 0.2$ $\times 2$ $= 0.064$ or $^{8}/_{125}$	M1 M1 A1 3	or $0.2 \times 0.8^{0} \times 0.8 \times 0.2$ or $0.2 \times 0.8 \times 0.2 + 0.8 \times 0.2 \times 0.2$	or 0.032 NOT $n \times 0.2^{2} \times 0.8$ except $n = 2$ Fully correct method except allow M0M1 for $(0.2+0.8\times0.2) \times 2$, must see method Attempt 0,3 and/or 3,0, as well as 2,1and/or 1,2; max M1M0A0 Careful: $0.2\times0.8\times0.2+0.2\times0.8^{-1}\times0.128 = 0.064$ M1M0A0 Careful: $0.8\times0.8\times0.2 \div 2 = 0.064$: (ie P($X = 3$) ÷ 2) M0M0A0
Total		**11**		
3i	$\frac{7351.12-\frac{86.6\times943.8}{12}}{\sqrt{(658.76-\frac{86.6^2}{12})(83663-\frac{943.8^2}{12})}}$ or $\frac{540.03}{\sqrt{33.80\times9433}}$ $= 0.9564\ldots$ or 0.956 or 0.96	M1 M1 A1 3	Must see at least 2 sfs	1st M1 for correct subst in any correct S formula 2nd M1 for all correct subst'n in any correct r formula 0.96 or correct better, no working: M1M1A1 eg 0.958 → 0.96 with correct working M1M1A0 without working: M0M0A0
ii	Strong (or high or good or close etc) relationship (or corr'n or link) between amount spent on advert & profit	B1 1	Allow Almost complete relationship or Very positive corr'n or Very reliable relationship or Near perfect relationship between spend on advert & profit oe, in context	Must state or imply "strong" or "good" or equiv & in context but NOT Strong *agreement* between etc NOT High spend on ads produces high profits NOT The more spent on adverts, the higher the profit NOT Positive corr'n between spend on ads & profits NOT There is a relationship between spend on ads & profit NOT There is a great relationship between etc NOT ans involving "proportion(al)" Ignore irrelevant or incorrect If incorrect r (< 0.9) in (i), no ft for ans "weak rel'nship" here; but correct ans here scores B1 even if inconsistent with their r

iii	Relationship may not continue	B1	Can't extrapolate Any indication that pattern may not continue Must state or imply referring to future	Allow without context Examples: Can't predict future; Things can change May be recession ahead; Economic situation may change Cost of advertising may increase If spend too much on ads, profit may be reduced as a result Advertising may not be as successful in the future Item may go out of fashion NOT Spending on adverts may not bring high profits NOT Spending more on adverts may not bring higher profits (Since these just restate the question) NOT More money spent on ads will not affect profit
	Corr'n not imply causation	B1 2	Increase in profit may not be due to increase in spend on advertising. Variables may be increasing separately	Both variables may be affected by a third Other factors may affect profits Advertising not the sole factor affecting profits Two different categories of reason needed, as given above. Two reasons which both fall under the same category: only B1 NOT Because corr'n not equal to 1
iv	$b = \dfrac{7351.12 - \frac{86.6 \times 943.8}{12}}{658.76 - \frac{86.6^2}{12}}$ = 15.9788 or 16.0 $y - \frac{943.8}{12} =$ "16.0"$(x - \frac{86.6}{12})$ $y = 16x - 37$ or better	M1 A1 M1 A1 4	or $\dfrac{S_{xy}}{Sxx}$ or $a = \frac{943.8}{12} -$ "16.0" $\times \frac{86.6}{12}$ ($y = 15.9788x - 36.664$)	ft values of S_{xy} & S_{xx} if clearly shown in (i) Coeffs not nec'y rounded, but would round to 16 & 37 These marks can be earned in (v) if not contradicted in (iv) If x on y line found: M-marks only ($x = 2.71 + 0.0572y$)
v	"16" × 7.4 – "37" 81400 to 81750	M1 A1f 2	81.4 thousand to 81.7 thousand: M1A1 but 81.4 to 81.7 alone: M1A0	"16" × 7400 – "37": M0A0 ft their (iv)
Total		**12**		

4i	0.4×0.7 $0.6 + 0.4 \times 0.7$ $= 0.88$	M1 M1 A1 3	or 0.6 + prod of 2 probs Condone $0.6 \times 0.7 + 0.6 \times 0.3 + 0.4 \times 0.7$ or $0.6 \times 0.6 + 0.6 \times 0.4 + 0.4 \times 0.7$	1– prod of 2 P's or 0.4×0.3 $1 - 0.4 \times 0.3$
ii	$p + (1 - p) \times p = 0.51$ or $2p - p^2 = 0.51$ $p^2 - 2p + 0.51 = 0$ $(p-0.3)(p-1.7) = 0$ or $p = \frac{2 \pm \sqrt{4 - 4 \times 0.51}}{2}$ oe $p = 0.3$	M1 A1 M1 A1 4	or $p^2 + p \times (1 - p) + (1 - p) \times p$ Correct QE = 0 Condone omission of "= 0" Correct method for their 3-term QE Not $p = 0.3$ or 1.7	Condone $p + p \times 1 - p$ M1, but $p + qp = 0.51$ M0 or $(1 - p)^2 = 0.49$ M1A1 $1 - p = \pm 0.7$ M1 must have ± Correct ans from correct but reduced wking or T & I or verification or no wking: 4 mks Ans $p = 0.3$ or 1.7 from correct but reduced wking or T & I or no wking: M1M1M1A0 Ans $p = 0.3$ following correct wking except other solution incorrect: BOD 4 mks (eg $p = \frac{2 \pm \sqrt{4 - 4 \times 0.51}}{2}$ so $p = 0.3$ or -1.3 so $p = 0.3$: 4 mks)) $p = 0.3$ from wrong wking but correct verification: BOD 4 mks $p = 0.3$ from wrong wking alone: M0A0M0A0
Total		**7**		

5			Consistent use of $\frac{1}{3}$ or MR of 30% (eg 0.2): ("Consistent" as in Qu 2) (i) B1B0B1B1 (iia) B0 (iib) 0.7901–0.4609 or ${}^5C_2(\frac{2}{3})^3(\frac{1}{3})^2$ M1; = 0.329 (3 sf) A1 (iii) p = "0.3292" M1; ${}^7C_3(1 - \text{"0.3292"})^4(\text{"0.3292"})^3$ M1; = 0.253 (3 sf) A1 ie max 8/10	
5i	Binomial or B (5, 0.3) Prob of gift same for all pkts Whether pkt contains gift is indep of other pkts	B1 B1 B1 B1 4	Prob of gift is constant or fixed or consistent or same oe Obtaining a gift is indep Each time receive a gift is indep Context needed for 3rd & 4th B-mks	Allow mis-spellings but NOT "Biometric" Condone B~(5, 0.3) or B(0.3, 5): B1B1 but B(X = 0.3, n = 5): B1B0 NOT: prob of success const; NOT prob stays same each go One box doesn't affect another. Pkts indep. Gifts indep She buys packets separately Prob of a gift is indep Prob of gift indep of one another & const: B1B1 NOT: Each week is indep NOT: Number of gifts received is indep NOT: Events indep If Geo(0.3) stated, can score max B0B0B1B1 If Geo(5, 0.3) stated, can score max B0B1B1B1
iia	0.8369	B1 1	or 0.837	
b	0.8369 – 0.5282 or ${}^5C_2(0.7)^3(0.3)^2$ = 0.3087 or 0.309 (3 sf)	M1 A1 2		
iii	p = "0.3087" ${}^7C_3(1 - \text{"0.3087"})^4(\text{"0.3087"})^3$ = 0.235 (3 sf)	M1 M1 A1 3	(iib) used in a calc'n eg "0.3087" × 3	or B(7, "0.3087") stated or 1 – "0.3087" used instead of "0.3087" n = 35 or 15: max M1M0A0
Total		**10**		

6i	7! ÷ 3! 7! ÷ 2! ÷ 2! ÷ 3! = 420	M1 M1dep A1 3	But NOT $^7P_4$ or 7!/(7-4)! if seen	$\frac{7!}{3!+2!}$: M1M0 $\frac{7!}{3!\times n!}$ any n: M1M0
iia	$^5C_3$ or $^{10}C_4$ seen $^5C_3 \times {}^{10}C_4$ = 2100	M1 M1 A1 3	or 10 or 210	$\frac{^5C_3 \times {}^{10}C_4}{\text{anything}}$ M1M1A0 $^5P_3 \times {}^{10}P_4$ or 60 × 5040 or 302400: SC B1
b	$^4C_2 \times {}^9C_4$ or $^4C_3 \times {}^9C_3$ or 756 or 336 $^4C_2 \times {}^9C_4 + {}^4C_3 \times {}^9C_3$ or 1092 ÷ 2100 or ÷ (iia) dep ≥ one M1 scored = $\frac{13}{25}$ or 0.52 "2100" – ($^4C_3 \times {}^9C_4$ or $^4C_2 \times {}^9C_3$) or "2100" – (504 or 504) M1 "2100" – ($^4C_3 \times {}^9C_4 + {}^4C_2 \times {}^9C_3$) M1 ÷ "2100" or (iia) dep ≥ M1 M1	M1 M1 M1dep A1 4	$\frac{3}{5}$ or $\frac{4}{10}$ oe $\frac{3}{5}\times(1-\frac{4}{10})$ or $(1-\frac{3}{5})\times\frac{4}{10}$ $\frac{3}{5}\times(1-\frac{4}{10}) + (1-\frac{3}{5})\times\frac{4}{10}$ = $\frac{13}{25}$ $\frac{3}{5}$ or $\frac{4}{10}$ oe M1 $\frac{3}{5}+\frac{4}{10}-\frac{3}{5}\times\frac{4}{10}$ M1 $\frac{3}{5}+\frac{4}{10}-\frac{3}{5}\times\frac{4}{10}-\frac{3}{5}\times\frac{4}{10}$ M1 = $\frac{13}{25}$ A1	Not from incorrect wking SC $\frac{1}{5}\times\frac{9}{10}$ or $\frac{4}{5}\times\frac{1}{10}$ M1 $\frac{1}{5}\times\frac{9}{10} + \frac{4}{5}\times\frac{1}{10}$ M1 (= $\frac{13}{50}$ A0) Not from incorrect wking ie P(WA or GA or both) Must be correct figures ie P(WA or GA but not both) Must be correct figures SC : $^4P_2 \times {}^9P_4 + {}^4P_3 \times {}^9P_3$: M1 ÷ (iia) M1dep Careful: 336 or 756 can be obtained by incorrect methods.
Total		**10**		

7i	$(0\times a) + 2\times(1-a)$ $= 2 - 2a$ or $2(1-a)$ oe	M1 A1 2	or $2(1-a)$ Not ISW	Condone $2 \times 1 - a$ NB $2\times(1-a) \div 2$: M0A0 Eg E(X) = $2 - 2a$; $2 - 2a = 1$; $a = 0.5$: M1A0
ii	$(0\times a) + 2^2\times(1-a)$ $-$ "$(2-2a)$"^{2} $= 4 - 4a - 4 + 8a - 4a^2$ $= 4a - 4a^2$ $(= 4a(1-a))$ **AG** $-2+2a$ | $2a$ a | $1-a$ M1 Var(X) $= a(-2+2a)^2 + 4a^2(1-a)$ M1 $4a^3 - 8a^2 + 4a + 4a^2 - 4a^3$ $4a - 4a^2$ A1	M1 M1 A1 3	or $4 - 4a$ oe $-$ (i)^2 dep contains a; ISW; Indep mk or $4(1-a) - 4(1-a)^2$ $4(1-a)(1-(1-a))$ Correct table oe	Condone $2^2 \times 1 - a$ $4 - 4a - 4 \pm 8a \pm 4a^2$ or $4 - 4a - 4 \pm 4a^2$ or equiv M1M1A0 $4 - 4a - 2(1-a)^2$ M1M1A0 Must see this line, correctly obtained Careful: $4 - 4a - (2-2a)^2 = 4 - 4a - (4 - 4a^2) = -4a + 4a^2 = 4a(1-a)$ M1M1A0 only
Total		**5**		
8i	EDCBA	B1 1	A 5 B 4 C 3 D 2 E 1	NOT just 5, 4, 3, 2, 1
iia	$1 - \frac{6\Sigma d^2}{5(5^2-1)} = 0.9$ $1 - \frac{6\times\Sigma d^2}{5\times24} = 0.9$ or $0.1 = \frac{6\times\Sigma d^2}{5\times24}$ ($\Sigma d^2 = 2$ **AG**)	M1 A1 2	 One correct step or better & nothing incorrect for A1	$1 - \frac{6\times2}{5(5^2-1)}$ $= 1 - \frac{6\times2}{5\times24}$ or $1 - \frac{12}{5\times(5^2-1)}$ One correct step or better & nothing incorrect for A1 (= 0.9 **AG**)
b	d^2: 0, 0, 0, 1, 1 any order BACDE or similar	M1 A1 2	or d: 0, 0, 0, 1, -1 any order Any two adjacent dogs interchanged	May not be seen If **clearly** comparing second race with third; DECBA or similar: B1, but must be clear
Total		**5**		

Total 72 marks

Note: "(3 sfs)" means "answer which rounds to … to 3 sfs". If correct ans seen to ≥ 3sfs, ISW for later rounding
Penalise over-rounding only once in paper.

1ia	$\frac{3247-\frac{251\times65}{5}}{\sqrt{(14323-\frac{251^2}{5})(855-\frac{65^2}{5})}}$ or $\frac{-16}{\sqrt{1722.8\times10}}$ = –0.1219…	M2 A1 3	M1 for correct subst in any correct *S* formula M2 for correct subst'n in any correct *r* formula Must see at least 4 sfs	or $\frac{-80}{\sqrt{8614\times50}}$ Allow –0.1218
b	Poor/no/little/weak/not strong corr'n or rel'nship or link between income & distance oe	B1 1	or slight neg/weak corr'n (oe) between income & distance In context, ie <u>any</u> comment on income & distance, even if incorrect	eg, Poor neg corr'n, so higher distance, lower income No rel'nship. Low income doesn't cause low distance NOT "Not proportional …" NOT "negative corr'n …" No recovery of this mark in (ii)
c	No effect or -0.122 oe	B1 1	eg "Nothing" or "None" oe	Ignore other NOT "Little effect" NOT "Not much effect"
ii	*r* close to 0, or small, or poor corr'n oe or *r* = –0.122 Unreliable	B1 B1dep 2	or Weak/no corr'n or poor rel'nship oe or No evidence to link sales & distance Condone "innacurate"or "incorrect" or "less reliable" or "not that reliable" "The data is unreliable" Must have correct reason	or because small sample Ignore other Allow: "Unreliable because pts do not fit a st line" "Unreliable because pts are scattered" "Unreliable because not strong neg …." "Unreliable because *r* not close to -1" "Unreliable because *r* smaller than (–)0.7" NOT "Unreliable because extrapolated": B0B0 but "Unreliable because extrapolated and poor corr'n": B1B1
Total		**7**		

2	Attempt ranks 4 1 2 3 or 1 2 3 4 or 1 2 3 4 oe 2 1 3 4 1 3 4 2 1 4 2 3 Σd^2 attempted (or 6) $1-\frac{6\Sigma d^2}{4(4^2-1)}$ $=\frac{2}{5}$ oe	M1 A1 M1 M1 A1 5	Ignore labels of rows or columns No ranks seen, d = (0), ±1, ±1, ±2, or d^2 = (0), 1, 1, 4 any order: M1A1 NOT $(\Sigma d)^2$	No wking, Σd^2 = 6: M1A1M1 No wking, Σd^2 = eg 14: M0A0M0, but can gain 3rd M1 No wking, ans $\frac{2}{5}$: Full mks Allow both sets of ranks reversed NB incorrect method: 2 3 4 1 2 1 3 4 OR d = (0), ±2, ±1, ±3 any order OR d^2 = (0), 4, 1, 9 any order (leading to Σd^2 = 14 and $r_s = -\frac{2}{5}$): M0A0M1M1A0
Total		**5**		
3ia	$(1 - 0.5565)$ or $12\times0.85^{11}\times(1-0.85)+0.85^{12}$ = 0.4435 or 0.443 or 0.444 (3 sf)	M1 A1 2	or $1 - ((1\text{-}0.85)^{12}\ldots{}^{12}C_{10}\times0.85^{10}(1\text{-}0.85)^2)$ ie 1 – (all 11 correct binomial terms)	or 1 – 0.557 NB 1 – 0.4435 (oe): M0A0
b	$0.5565 - 0.2642$ or $^{12}C_{10}(1-0.85)^2(0.85)^{10}$ = 0.2923 or 0.2924 or 0.292 (3 sf)	M1 A1 2		or 0.557 – 0.264
c	$12 \times 0.85 \times (1-0.85)$ = 1.53 oe	M1 A1 2		
ii	$(\frac{3}{4})^2$ AND $\frac{3}{4}\times\frac{1}{4}$ seen (possibly × 2) $(\frac{3}{4})^2 \times 2 \times \frac{3}{4}\times\frac{1}{4}$ oe or $\frac{27}{128}$ or 0.211 $2 \times (\frac{3}{4})^2 \times 2 \times \frac{3}{4}\times\frac{1}{4}$ oe = $\frac{27}{64}$ or 0.422 (3 sfs)	M1 M1 M1 A1 4	eg $(\frac{3}{4})^2+\frac{3}{4}\times\frac{1}{4}$ or $2\times(\frac{3}{4})^2+2\times\frac{3}{4}\times\frac{1}{4}$ or 0.5625 + 0.1875 or 0.5625 + 0.375 or eg 0.5625 × 0.375 Fully correct method	or $\frac{9}{16}$ and $\frac{3}{16}$ or $\frac{9}{16}$ and $\frac{3}{8}$ eg in table or list Allow even if further incorrect wking Ans 0.211: check wking but probably gets M1M1M0A0 Use of 0.85 instead of $\frac{1}{4}$: MR max M1M1M1A0
Total		**10**		

4i	Method is either: Just $4 \div 3$ or $\frac{4}{3}$ or: Use of ratio of correct frequencies AND ratio of widths (correct or 4 and 2)			
4i	$5.6 \times \frac{4}{28} \times \frac{5}{3}$ or $0.8 \times \frac{5}{3}$ or $(5.6 \div \frac{28}{5}) \times \frac{4}{3}$ or $\frac{4}{3}$ or $4 \div 3$ oe $= 1\frac{1}{3}$ or $\frac{4}{3}$ or 1.33 (3 sf) oe	M2 A1 3	M1 for $5.6 \times \frac{4}{28} \times \frac{4}{2}$ or $0.8 \times \frac{4}{2}$ or $(5.6 \div \frac{28}{4}) \times \frac{4}{2}$ or 0.8×2 oe (= 1.6) No wking, ans 1.3: M2A0 Ans 1.6: Check wking but probably M1M0A0	Correct calc'n using 5.6, 28, 4, 5, 3 oe: M2 Correct calc'n using 5.6, 28, 4, 4, 2 oe: M1 ie fully correct method: M2 or: incorrect class widths, otherwise correct method: M1 $\frac{4}{3}$ correctly obtained (or no wking) then further incorrect: M1M0A0 Use of ratio of widths OR freqs but not both: M0 eg $5.6 \times \frac{4}{28}$ (= 0.8) or $5.6 \times \frac{3}{5}$ (= 3.36): M0 $\frac{4}{2} = 2$: M0M0A0
ii	25 or 26 or 25.5 Med is 21st (or 22nd or 21.5th) in 31-35 class or "25 – 4" Can be implied by calc'n Med > 33 or "more than"	B1 B1 B1 3	or 25 & 26 or med in last ≈ 7 in class or $33 \approx 14^{th}$ in class or $33 \approx 18^{th}$ in whole set Can be implied by diagram indep	May be implied, eg by 21 or 22 or 21.5 Calc'ns need not be correct but need to contain relevant figures for gaining B1B1 The "≈" sign means ± 2 <u>Alternative Method</u>: $33 \approx 18^{th}$ value B1 More values above 33 than below oe B1 Med > 33 B1 Ignore comment on skew NB Use EITHER the main method OR the <u>Alternative Method</u> (above), not a mixture of the two. Choose the method that gives most marks.

iii	$\geq$ 3 mid-pts attempted $\Sigma fx \div 50$ attempted (= $\frac{1819}{50}$) = 36.38 or 36.4 (3 sf) Σfx^2 attempted (= 68055.5) $\sqrt{\frac{68055.5}{50} - (\frac{1819}{50})^2}$ or $\sqrt{1361.11 - 36.38^2}$ (= $\sqrt{37.6056}$) = 6.13 (3 sfs) Alt for variance: $\Sigma f(x - \bar{x})^2$ (= 1880.28) M1 $\sqrt{\frac{1880.28}{50}}$ M1 = 6.13 (3 sf) A1	M1 M1 A1 M1 M1 A1 6	seen or implied $\geq$ 3 terms. or 36 with correct working $\geq$ 3 terms. completely correct method except midpts & ft their mean, dep not $\sqrt{}$(neg)	Not nec'y correct values (29, 33, 40.5, 53) Allow on boundaries. Not class widths Allow on boundaries. Not class widths (3364, 30492, 22963.5, 11236) Allow class widths for this mark only NB mark is not just for "– mean^2", unlike q5(iii) $\Sigma(fx)^2$: M0M0A0 If no wking for Σfx^2, check using their x and f If no wking or unclear wking: full mks for each correct ans for incorrect ans: $35.8 \leq \mu \leq 36.9$ M0M1A0 $6.0 \leq$ sd ≤ 6.25 M1M0A0
iv	(a) Decrease (b) Increase (c) Same (d) Same	B1B1 B1B1 4	Ignore other, eg "slightly" or "probably"	Ignore any comments or reasons, even if incorrect
Total		**16**		
5	If done with replacement, no marks in any part of this question.			
5i	All correct probs correctly placed, matching labels, if any	B2 2	B1 for 4 correct probs anywhere	Allow B2 with missing labels but only if probs consistently placed, ie R above B throughout
ii	$\frac{4}{10} \times \frac{6}{9} + \frac{6}{10} \times \frac{4}{9} \times \frac{5}{8} + \frac{6}{10} \times \frac{5}{9} \times \frac{4}{8}$ or $\frac{4}{15} + \frac{1}{6} + \frac{1}{6}$ (= $\frac{3}{5}$ **AG**)	B2 2	B1: two of these products (or their results) added (not multiplied) or $1 - (\frac{6}{10} \times \frac{5}{9} \times \frac{4}{8} + \frac{6}{10} \times \frac{4}{9} \times \frac{3}{8} + \frac{4}{10} \times \frac{3}{9})$ or $1 - (\frac{1}{6} + \frac{1}{10} + \frac{2}{15})$	B1: 1 – two of these products (or results) added (not multiplied) NB incorrect methods can lead to correct ans **AG** so no wking no mks No ft from tree in (i)

iii	Σxp attempted $= \frac{16}{15}$ oe or 1.07 (3 sfs)	M1 A1	Both non-zero terms ÷ 3 etc or $\frac{1}{\Sigma xp}$: M0	
	Σx^2p attempted (= $\frac{23}{15}$ or 1.53) – "$\frac{16}{15}$"^{2}	M1 M1	Both non-zero terms ÷ 3 etc: or $\frac{1}{\Sigma x^2p}$: M0 indep but dep +ve result	Not Σxp^2 NB easier to gain than equiv mark in qu 4(iii)
	$= \frac{89}{225}$ oe or $0.39\dot{5}$ or 0.396 (3 sfs)	A1 5	Ans 0.388: check wking but probably comes from μ = 1.07; premature rounding: M1M1A0	not 0.395, but check for dot over 5 for recurring
	Alt for Var(X): $\Sigma(x-\bar{x})^2p$ M2		$\frac{1}{6}\times\frac{16}{15}^2 + \frac{3}{5}\times\frac{1}{15}^2 + \frac{7}{30}\times\frac{14}{15}^2$ all correct M2, 2 terms correct M1	
Total		**9**		
6ia	5040	B1 1		
b	6! or 5!×6 or 720 ÷ 7! or ÷ "5040" or 1440 or (5! or 6!) × 2 $= {}^2/_7$ oe or 0.286 (3 sf)	M1 M1 A1 3	Any ÷ 7! or "5040" but NOT any × 2 $^1/_7\times{}^1/_6$ M1* × 6 or × 2 M1 dep*	NOT 6! in denom eg $^{6!}/_{5040}$ or $^1/_7$ or 0.143 or $^1/_{21}$ (3 sfs): M1M1A0
iia	3! × 4! alone or 144 (÷ 7! or "5040") $= {}^1/_{35}$ oe or 0.0286 (3sf)	M1 A1 2	$^4/_7\times{}^3/_6\times{}^3/_5\times{}^2/_4\times{}^2/_3\times{}^1/_2$ oe or $\frac{1}{7C3 \text{ or } 7C4}$	Not 3! × 4! ×… (eg not 3! × 4! × 5) not $\frac{1}{31\times4!}$, not $\frac{1}{144}$ NB no mark for ÷ 7! or "5040" in this part
b	5 seen or 5! seen 3! × 4! × 5 or 5! × 3! or 720 or 5 × 144 (÷7! or "5040") $= {}^1/_7$ oe or 0.143 (3 sf)	M1 M1 A1 3	or $5\times{}^3/_7\times{}^2/_6\times{}^1/_5$ ($\times{}^4/_4\times{}^3/_3\times{}^2/_2$) oe: M2 or $5\times\frac{1}{7C3 \text{ or } 7C4}$: M2 or 5 × "(iia)": M2	or GGGBBBB, BGGGBBB, BBGGGBB, BBBGGGB, BBBBGGG NB no mark for ÷ 7! or "5040" in this part
Total		**9**		

7i	*x*	B1 1	Ignore explanations. "Neither" or "Both": B0	
ii	Diag showing vertical differences only State that sum of squares of these is min oe	B1 B1 2	Allow description instead of diag: "Distances from pts to line // to *y*-axis" oe dep vert or horiz lines (not both) drawn or described	Allow $\geq$ one line, from a point to the line Must have Min, Squares, Distances & Sum
iii	–1 Ranks opposite or reversed or perfect neg corr'n between ranks oe	B1 B1dep 2	Not approx –1 As *x* increases, *y* decreases	Allow eg: –1 because neg corr'n so ranks must be reversed Ignore other NOT neg corr'n or strong neg rel'nship oe NOT comment about "disagreement" or "agreement"
iv	"Negative" or "Not –1"	 B1 1	eg "Strong neg" or any negative value > –1 or "Close to –1"	Any implication of Negative, except NOT "Negative gradient" and NOT "–1" given as the value of *r*
Total		**6**		
8	Incorrect *p* (eg "cubical die means 18 sides hence $p = \frac{1}{18}$"): can gain all B & M marks.			
8i	$^{25}/_{216}$ oe or 0.116 (3 sfs)	B1 1		
ii	$(^5/_6)^7 \times {}^1/_6$ alone = 0.0465 (3 sfs) or $\frac{78125}{1679616}$	M2 A1 3	M1 for $(^5/_6)^8 \times {}^1/_6$ alone	
iii	$(^5/_6)^8$ oe alone = 0.233 (3 sfs) or $\frac{390625}{1679616}$	M1 A1 2	1 – P($X \leq 8$), with exactly 8 correct terms	NOT $1 - (\frac{5}{6})^8$, NOT $(\frac{5}{6})^8 \times \ldots$.
iv	NB If more than 5 products are added (eg P($1 \leq X \leq 12$): no marks			
	$(^5/_6)^9\times{}^1/_6 + (^5/_6)^{10}\times{}^1/_6 + (^5/_6)^{11}\times{}^1/_6 + (^5/_6)^{12}\times{}^1/_6$ (= 0.0323 + 0.0268 + 0.0224 + 0.0187)	M3	M3 for all correct or M2 for 3 of these added or these 4 plus 1 extra or 0.0817 or 0.0680 or 0.139 or 0.116 or M1 for $\geq$ 1 of these terms or values seen; ignore incorrect	$(^5/_6)^9 - (^5/_6)^{13}$ or $1 - (^5/_6)^{13} - [1 - (^5/_6)^9]$ M3 or $(^5/_6)^{8,\ 9\text{ or }10} - (^5/_6)^{12,\ 13\text{ or }14}$ or $1 - (^5/_6)^{12,\ 13\text{ or }14} - [(1 - (^5/_6)^{8,\ 9\text{ or }10}]$ M2 or $\pm[(^5/_6)^9 - (1 - (^5/_6)^{13})]$ or $\pm\,[1-(^5/_6)^9 - (^5/_6)^{13}]$ M1
	= 0.100 (3 sfs)	A1 4	Allow 0.1 with wking	
Total		**10**		

Total 72 marks

Note: "(3 sf)" means "answer which rounds to ... to 3 sf". If correct ans seen to ≥ 3sf, ISW for later rounding
Penalise over-rounding only once in paper. NB If marking by question and over-rounding is seen, must mark whole paper.

Question			Answer	Marks	Guidance	
1	(i)		$0.1 + 0.3 + 2p + p = 1$ oe $p = 0.2$	M1 A1 [2]		
1	(ii)		Σxp $= 2.7$ oe	M1 A1f [2]	≥ 2 terms correct, FT p	eg ÷ 4: M0A0
2	(i)		x because values (or depths) are fixed (or controlled or chosen or predetermined or manipulated or given oe) because they can be changed or it is changed or because it is not measured ie not "read off" oe or because we change the values ourselves	 B1 [1]	Allow "because it goes up in intervals" or "because it is taken at set intervals" Ignore all else NB "x is changed" B1, but "x changes" B0	NOT: x, as values are constant x, as y depends on x x as % sand depends on depth Depth, as not affected by % sand content x, as it is not dependent x, because y is measured x, because it changes y, which is the depth and this is controlled
2	(ii)		$S_{xx} = 7344 - \frac{216^2}{9}$ (= 2160) $S_{yy} = 30595 - \frac{512.4^2}{9}$ (= 1422.36) $S_{xy} = 10674 - \frac{216 \times 512.4}{9}$ (= – 1623.6) $r = \frac{"-1623.6"}{\sqrt{"2160" \times "1422.36"}}$ = –0.926 (3 sfs)	 M1 M1 A1 [3]	correct subst in any S formula correct subst in all Ss & in r	

Question			Answer	Marks	Guidance	
2	(iii)	(a)	$b = \frac{"-1623.6"}{"2160"}$ or $-0.75\ldots$ or $-\frac{451}{600}$ $y - \frac{512.4}{9} = "-0.75\ldots"(x - \frac{216}{9})$ $y = -0.75x + 75(.0)$ (2 sf) or $y = -\frac{451}{600}x + \frac{5623}{75}$	M1 M1 A1 [3]	ft S_{xy} & S_{xx} from **(ii)** or $a = \frac{512.4}{9} - 0.75\ldots \times (-\frac{216}{9})$ or $\frac{5623}{75}$ 2 sf is enough Allow $y = -0.75x + (-75)$	If ans to **(i)** is y, & x on y found here: $b' = \frac{"-1623.6"}{"1422.36"}$ $(= -1.14)$ M1 $x - \frac{216}{9} = "-1.14"(y - \frac{512.4}{9})$ M1 $x = -1.14y + 89(.0)$ A1 If ans to **(i)** is x, but x on y found here: B1 only for $x = -1.14y + 89(.0)$
2	(iii)	(b)	r close to -1 (or high or strong), $\lvert r\rvert$ close to 1 25 within range of data oe, so reliable 100 outside range of data oe, so unreliable Must give reasons Allow "accurate" instead of "reliable"	B1 B1 B1 [3]	Allow strong or good or high corr'n or rel'nship etc or …. so more reliable or …. so less reliable If (ii) $\lvert r\rvert < 0.7$: poor corr'n oe B1f 25 unreliable B1f 100 unreliable B1f	or strong neg corr'n. Award this mark even if comment linked to 100 instead of linked to 25. BUT: "r close to -1, so unreliable": B0 Can still score next marks if mention "within" and "outside range" or 100 gives neg %age ….. "Reliable because r near -1" B1B0B0 "Small sample so unreliable" B0B0B0 Ignore all else
3	(i)		$(1 - 0.12)^{13}$ or $13\times(1 - 0.12)^{12}\times 0.12$ $(1 - 0.12)^{13} + 13\times(1 - 0.12)^{12}\times 0.12$ $= 0.526$ (3 sf)	M1 M1 A1[3]	Either seen Fully correct method	1 – correct terms: M1M0A0
3	(ii)		${}^{13}C_2\times 0.12^2\times(1 - 0.12)^{11}$ $2 \times$ "0.275275" $\times (1 -$ "0.275275") $= 0.399$ (3 sf)	M1 M1 A1 [3]	or 0.275(…) Correct method except allow omit "2 ×"	Allow if × or + something NB unlike 2nd M1 in (i) which is for fully correct method NB $2 \times 0.12 \times 0.88$: M0M0A0

Question			Answer	Marks	Guidance	
4	(a)		3 5 1 4 2 3 1 5 2 4 1 4 3 5 2 5 2 3 1 4	M1 A1	Attempt ranks for both variables Correct ranks May be implied by $\Sigma d^2 = 10$	If use alphabetical order for one or both sets of ranks, M0A0. eg if 1, 2, 3, 4, 5, seen or $\Sigma d^2 = 14$ or 16, check carefully. But can score 2nd & 3rd M1s. Also see example below
			Σd^2 attempted (= 10)	M1	S_{xx} or $S_{yy} = 55 - \frac{15^2}{5}$ (=10) or $S_{xy} = 50 - \frac{15^2}{5}$ (=5)	
			$r_s = 1 - \frac{6\Sigma d^2}{5(5^2-1)}$ dep $\geq$ M1 gained = 0.5	M1 A1 [5]	$\frac{5}{\sqrt{10\times10}}$	A = 1, B = 2 etc eg 2 4 1 5 3 4 2 3 5 1 Max M0A0M1M1A0
4	(b)		$n(n^2 - 1)$ greater or increases or becomes $(n+1)((n+1)^2 - 1)$	B1ind	or "denom increases" or "÷ by larger number"or "fraction decreases" or "value taken from 1 decreases" oe	Allow increases to 6×35 NOT just "n increases"
			Σd^2 unchanged (or not increase) Allow d^2 unchanged	B1ind	or $d = 0$ or $d^2 = 0$ or the difference is 0	NOT $n(n^2 - 1)$ changes NOT "difference is unchanged"
			r_s greater	B1 [3]	dep $\geq$ B1 or no explanation "Little diff between rankings so r_s same" or "rankings unchanged" B0B0B0	Use of incorrect formula can score max B1B1B0 (B0 for r_s greater) "Increases because more agreement" B1 only
5	(i)	(a)	$(\frac{6}{3} =) 2$	B1 [1]	$(\frac{6}{9} \times 3 =) 2$	
5	(i)	(b)	$^2/_6 \times 2$ $= {}^2/_3$ oe or 0.667 or 0.67 or 0.7	M1 A1[2]	Allow $^2/_5 \times 2$ or ans 0.8 for M1	Can be implied, eg $\frac{1}{3} = 0.3$, ans 0.6: M1A0 Allow 0.66 or 0.666

Question			Answer	Marks	Guidance	
5	(ii)		(3.5, 6) (0.5, 0) or (6.5, 15)	B1 B1 [2]	Ignore incorrect	(6, 3.5) AND (15, 6.5): B1
5	(iii)	(a)	$\frac{\Sigma xf}{21}$ = 5.43 (3 sf) or $\frac{114}{21}$ or $\frac{38}{7}$ oe $\frac{\Sigma x^2 f}{21}$ or $\frac{817.5}{21}$ or 38.9… – "5.43"^{2} or = 9.46 or 9.4592…. (√9.4592….) = 3.08 (3 sfs)	M1 A1 M1 M1 A1 [5]	Allow x within classes, incl end pts then ÷5: M0A0 Allow x within class, incl end pt ÷5: M0 dep +ve result; done before √; not $-(\bar{x}^2 \div \ldots)$	$\geq$ 2 non-zero terms correct ft their x $\geq$ 2 non-zero terms correct ft their x Calc 4 values of $(x-\bar{x})^2$ or $(x-\bar{x})^2 f$ or (11.8, 0.184, 6.61, 50) or (70.5, 1.65, 26.4, 100) or 199 M1 $\frac{\Sigma(x-\bar{x})^2 f}{21}$ fully correct method M1
5	(iii)	(b)	Actual values or exact hours unknown oe Don't have raw data. oe or measured to nearest hour oe	B1 [1]	or Data given in classes or grouped oe or Data evenly distributed in classes oe	Mid-points or medians or averages of class boundaries used oe

Question			Answer	Marks	Guidance	
6	(i)		V because [probs or values or geometric or etc] decreasing or halving or Highest prob is 1st Allow if word "decreasing" or "halving" or "sloping downwards" or any equivalent seen NOT "Positive skew"	B1 B1 [2]	*X* because mode = 1 oe or Highest prob is P(1) oe B2 *Z* because P(0) = 0 or variable can't be 0 oe Allow "Geo distr'n cannot be zero" oe B2 "None of them": Ignore any reason given. B2	For answer V the first B1 is indep, but not for other answers, ie: V with no reason or incorrect reason scores B1B0, but Z or X or any other letter with no reason or incorrect reason scores B0B0. In all cases, once mark(s) have been scored, ignore all other comments.
6	(ii)		Y. Peaks at 2 Y. Like normal, peak at 2 Y. Highest prob is middle one (or is at 2) Y. P($X = 2$) is max Y. Increase to 2 then decr Y. 1 4 6 4 1 alone or with $0.5^4 \times$ Y. 0.0625, 0.25, 0.375, 0.25, 0.0625 Y. P(1) = P(3) and P(2) is greater/different or equiv of any of the above	 B1B1B1	 Ignore all else	If values of <u>some</u> probs listed: 2 to 4 values: B1 Y: B1 For 3rd B1 must link list with Y diag, eg "symmetrical" or "peak in middle" or "peak at 2" or "1st = last" or "2nd = 4th" "same shape as Y diag". etc etc
			If none of the above applies: Any implication that values not all equal eg: Not uniform or values increase (then decrease) or there is a peak Symmetrical or mirror image oe or $^4C_0 = {}^4C_4$ or 2nd = 4th or similar or mean = 2, or E(X) = 2, or 2 is hi'est prob, or peak at 2, or peak is middle value Y	 B1 B1 B1 [3]	 $^4C_0$, $^4C_1$, $^4C_2$, etc indep indep indep	

Question			Answer	Marks	Guidance	
7	(i)		Geo(0.6) or G(0.6) or Geo with $p = 0.6$	B1B1	Allow Geo(60%) B1B1	Bin(…, 0.6) B0B1. Can still score comment marks
			P(woman) const or chance of woman const Each voter has same prob	B1	or %age of women is constant	In context
			Whether one voter is a woman is indep of whether any other is a woman	B1	Allow: "voter(s) independent", "Men & women are independent" "P(woman) is indep" "Each woman is indep"	Allow "vote indep" In context (EACH comment must be in context)
				[4]		Ignore all else
7	(ii)		$0.4^3 \times 0.6$ $= {}^{24}/_{625}$ or 0.0384	M1 A1f [2]	ft their Geo(p) from (i) ft their Geo(p) from (i)	Allow $0.3^3 \times 0.6$ (but no other $q^3 \times 0.6$) eg if $p = 0.4$, ans 0.0864 M1A1f
7	(iii)		0.4^3 alone, or $(0.4^4 + 0.4^3 \times 0.6)$ or $(0.4^4 +$ (ii))	M1	$1–(0.6 + 0.4\times0.6 + 0.4^2\times0.6)$ (allow extra term $0.4^3\times0.6$) ft their Geo(p) from (i)	Allow M1 for 0.4^4 alone (= 0.0256) M0 for $0.4^r \times 0.6$ and for $1 – 0.4^3$
			$= {}^{8}/_{125}$ or 0.064	A1f [2]	ft their Geo(p) from (i)	eg if $p = 0.4$, ans 0.216 M1A1f
8	(i)		Binomial stated	M1	or implied by $C\times0.5^r$ or use of table	or $0.5^7\times0.5 + 0.5^8$ or $0.5^8 + 0.5^8$
			$1 – 0.9648$	M1	or ${}^8C_7 \times 0.5^7\times0.5 + 0.5^8$ fully correct method	$1– (0.5^8+8\times0.5^8+{}^8C_2 0.5^8\ldots)$ all correct
			$= 0.0352$ (3 sfs) or ${}^9/_{256}$	A1 [3]		
8	(ii)	(a)	${}^{22}C_{11} \times 0.5^{11} \times 0.5^{11}$ $= 0.168$ (3 sfs)	M1 A1 [2]	Fully correct method. Not ISW	eg 0.168^2 or 2×0.168 or $1–0.168$: M0A0

Question			Answer	Marks	Guidance	
8	(ii)	(b)	1 – "0.168"	M1	or $0.5^{22}(^{22}C_{12} + {}^{22}C_{13} + {}^{22}C_{14} + \ldots + 22 + 1)$ All 11 correct terms seen, or correct ans: M2 or P(X = 12, 13, … 21, 22) stated or implied with $\geq$ 2 terms shown or one extra term M1	or $1 - (^{22}C_{12} + {}^{22}C_{13} + {}^{22}C_{14} + \ldots + 22 + 1)$ 1 – all 12 correct terms M2 or similar marks for P(X = 10, 9, 8…0)
			$^1/_2$(1 – "0.168") = 0.416 (3 sfs)	M1 A1 [3]		
9	(i)	(a)	$^9P_4$ or $^{9!}/_{5!}$ or $^9C_4 \times 4!$ = 3024	M1 A1 [2]	alone	oe eg $^9C_1 \times {}^8C_1 \times {}^7C_1 \times {}^6C_1$ or 9×8×7×6
9	(i)	(b)	$^8P_3$ or $8 \times 7 \times 6$ oe or $^8C_3 \times 3!$ $\times$ 5 (or $^5C_1$) = 1680	M1 M1 A1 [3]	Allow × …. or ÷ ….. Correct × 5 or $^8C_3 \times 5$ (or $^5C_1$) Not ISW, eg $^{1680}/_{3024}$: M1M1A0	or ($^9P_4$ or "3024") × $^5/_9$ M2
					SC: consistent use of with replacement in (i) (or if only (a) or (b) attempted) (ia) M0A0 (ib) 999 × 5 or 4995 M1 M0A0	

Question			Answer	Marks	Guidance	
9	(ii)	(a)	$^5C_3 \times {}^4C_1$ or $^5C_4$ oe $^5C_3 \times {}^4C_1 + {}^5C_4$ oe correct method so far (= 45) $\div {}^9C_4$ Allow anything $\div {}^9C_4$ $= {}^5/_{14}$ or 0.357 (3 sfs) oe, eg $^{35}/_{98}$ or $^{45}/_{126}$	M1 M1 M1 A1 [4]	$^5C_3 \times {}^4C_1 \times 4!$ (or $^5P_3 \times 4 \times 4$) or 5! (or $^5P_4$) 960 + 120 oe correct method so far $\div {}^9P_4$ [must involve any P or any !] $\div {}^9P_4$ Marks must come from one method, not mixture of two methods	$^5/_9 \times {}^4/_8 \times {}^3/_7 \times {}^4/_6$ Allow × or +… × 4 correct method so far $^5/_9 \times {}^4/_8 \times {}^3/_7 \times {}^2/_6$ Allow × or +… or: $^5/_9 \times {}^4/_8 \times {}^3/_7 \times {}^4/_6$ or $^5/_9 \times {}^4/_8 \times {}^3/_7$ M1 $^5/_9 \times {}^4/_8 \times {}^3/_7 \times {}^4/_6 \times 3 + {}^5/_9 \times {}^4/_8 \times {}^3/_7$ M1 NB $^5/_9 \times {}^4/_8 \times {}^3/_7 \times 3 = {}^5/_{14}$ M0M0M0A0
9	(ii)	(b)	9, 8, 7, 4 or 9, 8, 6, 5 No mark yet 2 $\div {}^9C_4$ oe Must be (1 or 2 or 4) $\div {}^9C_4$ $= {}^1/_{63}$ oe or 0.0159 (3 sfs)	M1 M1 A1 [3]	$^1/_9 \times {}^1/_8 \times {}^1/_7 \times {}^1/_6$ ¦ $^4/_9 \times {}^3/_8 \times {}^2/_7 \times {}^1/_6$ Allow × or +… × 4! × 2 ¦ × 2 fully correct method NB Marks from one method only, not mixed methods	4! + 4! or 2 × 4! oe $\div {}^9P_4$ or ÷ (i)(a) oe Must be (96 or 48 or 24) $\div {}^9P_4$ $^2/_9 \times {}^2/_8 \times {}^1/_7 \times {}^1/_6$ allow × or + … M1 × 4!/4 × 2 fully correct method M1
					SC: consistent use of with replacement in (ii), (or if only (a) or (b) attempted) (iia) $(^5/_9)^4$ M1 $+ {}^4C_3(^5/_9)^3(^4/_9)$ (= 0.400) M1 M0A0 (iib) $(^1/_9)^4$ (=0.000152) M1 attempt find no of gps M1A0	$1-((^4/_9)^4+4(^4/_9)^3(^5/_9)+{}^4C_2(^4/_9)^2(^5/_9)^2)$ M2 One term missing or extra or wrong M1

Question			Answer	Marks	Guidance	
1	(i)		$\Sigma x = 1366$ $\Sigma y = 17.6$ $\Sigma x^2 = 374460$ $\Sigma y^2 = 62.82$ $\Sigma xy = 4784.8$ $S_{xx} = 374460 - \frac{1366^2}{5}$ or 1268.8 $S_{yy} = 62.82 - \frac{17.6^2}{5}$ or 0.868 $S_{xy} = 4784.8 - \frac{1366\times17.6}{5}$ or –23.52 $r = \frac{-23.52}{\sqrt{1268.8\times0.868}}$ or $\frac{-23.52}{33.186...}$ oe = –0.709 (3 sfs)	B1 M1 M1 A1 **[4]**	any three correct; may be implied by 2 *S's* correct sub in any correct *S* formula, ft Σs, $\bar{x}$, $\bar{y}$ corr sub into 3 *S*s and *r*, ft Σs, $\bar{x}$, $\bar{y}$ cao	OR, using $S_{xx} = \Sigma(x - \bar{x})^2$ etc: $\bar{x} = \frac{1366}{5}$ or 273.2, $\bar{y} = \frac{17.6}{5}$ or 3.52, either:B1 $(-23.2)^2 + (-3.2)^2 + (-9.2)^2 + 16.8^2 + 18.8^2$ $0.68^2 + 0.18^2 + (-0.32)^2 + (-0.02)^2 + (-0.52)^2$ $(-23.2)\times0.68 + (-3.2)\times0.18 + (-9.2)\times(-0.32) + 16.8\times(-0.02) + 18.8\times(-0.52)$ If no working seen: –0.71: SC 3; –0.7: SC 1
1	(ii)		$b = \frac{"-23.52"}{"1268.8"}$ or $-\frac{147}{7930}$ or –0.0185 (3 sfs) $y - \frac{"17.6"}{5} =$ "–0.0185"$(x - \frac{"1366"}{5})$ $\Rightarrow y = -0.019x + 8.6$ or better, ie 2 sfs enough ($y = -0.019\times280 + 8.6$ (= 3.39 to 3.41)) Est sales = £3390 to £3410 or 3.39 thousand to 3.41 thousand	M1 M1 A1 A1ft **[4]**	ft their S_{xy} & S_{xx} & Σs from (i) or $a = \frac{"17.6"}{5} -$ "(–0.0185)" $\times \frac{"1366"}{5}$ if *a* incorrect, must see method for M1 cao; must be "$y = \ldots$" coeffs that round to –0.019 & 8.6 to 2 sfs ft their $y\times1000$, dep M1M1, dep sub 280 (not 280000) Allow "k" for thousand No working, ans in range: M1M1A0A1	use of *x* on *y* line: $b' = \frac{"-23.52"}{"0.868"}$ (or –27.1) M0 $x - \frac{"1366"}{5} =$ "–27.1"$(y - \frac{"17.6"}{5})$ or $a' = \frac{"1366"}{5} -$ "(–27.1)" $\times \frac{"17.6"}{5}$) M1 (if a' incorrect, must see method for M1) $x = -27.1y + 369$ cao A1 3277 or 3278 A0
1	(iii)		There may be other factors oe Correlation does not imply causation oe	 B1 **[1]**	or any suggestion of another factor that could be involved, eg Depends on state of the economy oe Must state or clearly imply: EITHER corr'n does not imply causation OR there could be another factor involved Ignore all else	NOT: Tourists & sales not nec'y linked Sales are not entirely dep on tourists Could be a coincidence Might be different other years More tourists wd incr sales –0.8 is not strong corr'n Only shows good neg corr'n Sample is small Could be affected by extremes Neg corr'n not nec'y imply neg relnship

Question			Answer	Marks	Guidance	
2			$\frac{1.4}{50}$ (= 0.028) $1.5 + \frac{1.4}{50}$ = 1.528 or $\frac{191}{125}$ or 1.53 (3 sf) $\frac{0.05}{50} - (\frac{1.4}{50})^2$ or 0.000216 seen $\sqrt{}0.000216$ = 0.0147 (3 sf)	M1 M1 dep M1 A1 M1 M1 A1 **[6]**	$1.4 + 50\times1.5$ (= 76.4) $\frac{'76.4'}{50}$ $(\Sigma x^2 - 2\times1.5\times'76.4' + 50\times1.5^2 = 0.05)$ $(\Rightarrow \Sigma x^2 = 116.75$; no marks yet) $\frac{0.05 + 2\times1.5\times'76.4' - 50\times1.5^2}{50} - '1.528'^2$ all correct fully correct method, ie nothing added etc cao not isw	eg $\frac{1.4+1.5}{50}$ M0M0A0 not $\frac{0.05}{50} - '1.528'^2$
3	(i)		23	B1 **[1]**	Allow 22.5	NOT 22 (ie 3.5th no) Correct ans is the 4th or 3.75th no.
3	(ii)		0 0	B1 B1 **[2]**	B1 for 30, 30	
3	(iii)		38 or 40 39 40.75	B2 **[2]**	B1 for 38 or 39 seen B2 for 38 & 39 seen alone, not in a range Mixture, eg 38, 40.75 B1B0 3/8 and 3/9 (both): B1B0 8 and 9(both): B1B0 40, 40.75: similar scheme as for 38, 39	eg 38, 38.5, 39 B1B0 (ie UQ = $^3/_4 \times 14 = 10.5^{th}$ no.) 'Between 39 & 46' B1B0 $38 \leq$ any letter < 40 B1B0 SC 42, 42.5 only B1B0 (ie UQ = 11.5th no.) Correct ans are the poss 11th or 11.25th nos

Question			Answer	Marks	Guidance	
3	(iv)		Shows all the data or you can see all the values oe You can see the actual/exact/indiv numbers/values/results No data is lost oe Shows the shape of the distribution oe Can perform calculations of your choice (eg mean) Shows which group (or class, NOT value) has the highest frequency (or is the mode) oe	B1 **[1]**	any implication of <u>all</u> the data or the <u>actual</u> numbers/values/results or similar eg Can compare each indiv result Easier to see the numbers eg can <u>find</u> frequencies No mks for ans to (v) given in (iv) unless labelled as (v)	NOT Shows the spread/skew/trend Any comment on skew You can <u>see</u> the actual frequ's Easier to compare sets of data Shows more info or more data Easier to read off the data Ignore all other
3	(v)		Shows the median or it's easier to see the median (or quartiles or IQR) It can measure the middle 50% easily	B1 **[1]**	eg Shows mean and quartiles B1 Shows range and median B1 No mks for ans to (v) given in (iv) unless labelled as (v) Ignore all other	NOT Shows the spread/skew/trend Can see data in diag form Shows max or min or range Easier to compare sets of data Not affected by outliers Easy to see outliers Shows s.d. or shows mean Can see important data items/measures
4	(i)		Top: 2 branches $\frac{4}{5}$, $\frac{1}{5}$ & R, B shown Bottom: 1st branch: prob = 1 or $\frac{5}{5}$, & R shown no 2nd branch OR branch with prob = 0 or $\frac{0}{5}$	B1 B1 **[2]**	consistent allow eg $\frac{4}{4}$ ignore any 3rd layer branches	 Any missing label(s) on first three branches, subtr B1 once No label needed on zero branch, if drawn.

Question			Answer	Marks	Guidance	
4	(ii)		$\frac{5}{6}\times\frac{1}{5}$ or $\frac{1}{6}(\times 1)$ or $\frac{1}{6}$ seen $\frac{5}{6}\times\frac{1}{5} + \frac{1}{6}(\times 1)$ $= \frac{1}{3}$ oe	M1 M1 A1 **[3]**	 all correct cao	or $1 - \frac{5}{6}\times\frac{4}{5}$ or $1 - \frac{2}{3}$ M2 ft incorrect tree dep probs ≤ 1 if 3rd tree prob = 1, (ii)M1M1A0 if 3rd tree prob $\neq 1$, (ii)M1M0A0 NB!! $2\times\frac{5}{6}\times\frac{1}{5} = \frac{1}{3}$ M1M0A0
4	(iii)		$\frac{4}{5}\times\frac{3}{4} + \frac{1}{5}(\times 1)$ or $1 - \frac{4}{5}\times\frac{1}{4}$ or 1 – 0.2 all correct $= \frac{4}{5}$ or 0.8 oe	M1 A1 **[2]**	or $(\frac{5}{6}\times\frac{4}{5}\times\frac{3}{4}+\frac{5}{6}\times\frac{1}{5})\div\frac{5}{6}$ all correct May be seen without working M1A1 cao	but $\frac{5}{6}\times(\frac{4}{5}\times\frac{3}{4}+\frac{1}{5})$ M0 ft incorrect tree: (iii) M1A0
5	(i)	(a)	1	B1 **[1]**		NOT close to 1
5	(i)	(b)	–1	B1 **[1]**		NOT close to –1
5	(ii)		Σd^2 attempted (= 10) $1 - \frac{6\times\Sigma d^2}{4(4^2-1)}$ = 0	M1 M1 A1 **[3]**	if $\Sigma d^2 = 10$, may be implied by next line if $\Sigma d^2 \neq 10$, must see working dep M1 Use of $(\Sigma d)^2$ M0M0A0	S_{xx} or $S_{yy} = 30 - \frac{100}{4}$ (= 5) or $S_{xy} = 25 - \frac{100}{4}$ (= 0) M1 $\frac{0}{\sqrt{5\times 5}}$ M1

Question			Answer	Marks	Guidance	
5	(iii)		No ft from (i)(a), (i)(b) & (ii)			NOT:
			ia: Total (or perfect or max or complete)agreement They have the same opinions/ranks/numbers etc They were identical	B1	Identical opinions/views/marks/ranks/ decisions/results/numbers oe Agree on all the ranks	They agree or Strongly agree They agree most ranks Similar rankings As A's ranks increase so do B's Perfect relnship
			ib: Opposite/reverse opinions/views/marks/ranks/ decisions/results oe	B1	Total (or max or complete or perfect) disagreement A's highest is B's lowest oe "Opposite" seen is sufficient	NOT: Don't agree any ranks Disagree or Strongly disagree Disagree on all ranks Perfect neg relnship
			ii: For $r = 0$ must state or imply:			NOT:
			either NO relationship or similar		No relationship/pattern/link/similarity between opinions/views/marks/ranks/ decisions/results oe opinions/etc… not related scoring appears random	Different views Don't agree but some rel'nshp Ranks all different No corr'n betw judges' views Don't agree nothing in common at all
			or indicate BOTH agreement & disagreement or NEITHER agree nor disagree		Neither agree nor disagree oe Both agree & disagree oe Agree for some, disagree for others oe mixed/varied opinions on the ranks	not much in common completely different orders opinions completely different half way between (a) and (b)
			or DIFFERENT but NOT OPPOSITE	B1	All three parts: Must refer to (or imply) opinions/views/marks/ranks/scores or (dis)agreement, or relationship or pattern oe, NOT just corr'n	Ignore all other
				[3]		

Question			Answer	Marks	Guidance	
6			$(1 - 0.1) \div 5$ (= 0.18) 3×0.18 or 2×0.18 or 7×0.1 (or result of these)(poss × 100) (3 × 0.18 only scores if using £3, not score of 3. Similarly for 2 × 0.18) . $4 \times 3 \times 0.18$ AND $2 \times 0.18 + 7\times0.1$ (poss × 100) (or 2.16 AND 1.06 or 216 AND 106) '2.16' – '1.06' or '216' – '106' must be attempt gain on 1,2,3,4 – loss on 5,6 E(profit for 100 rolls) = (£)110	M1 M1 M1 M1 dep any M1 A1 **[5]**	can be implied, eg by 18 5×0.18 or 10×0.1(or result of these)(poss × 100) 3 AND $5 \times 0.18+10 \times 0.1$ (poss × 100) (or 3 AND 1.9 or 300 AND 190) 3 – '1.9' or 300 – '190' must be attempt receipt – payout on 5,6 E(profit for 100 rolls) = (£)110 NB 300–(0.1×300+0.18×300) = 300–84 =216 M1M1M0M0A0	or, using exp no. of 5's & 6's 18×5 or 10×10 300 AND $18 \times 5 + 10 \times 10$ (NB 300+ 100×0.18 +100×0.1 is insuff) Eg: 300–100×(5×0.18+**6**×0.1)=150 M1M1M0M1A0 Mark one method only Must be matched pair eg 300–106 or 216–190: M1M1M0M0A0
7	(i)	(a)	${}^7P_5$ or $\frac{7!}{2!}$ or $7\times6\times5\times4\times3$ or ${}^7C_5 \times 5!$ alone = 2520	M1 A1 **[2]**	${}^7P_2$ or $\frac{7!}{2!}$ M0A0	${}^7C_5 = 21$ or 5! = 120 M0A0 but see (i)(b)
7	(i)	(b)	${}^6P_4$ or $\frac{6!}{2!}$ or $6\times5\times4\times3$ or ${}^6C_4 \times 4!$ or 360 × 2 (see middle column) = 720	M1 M1 A1 **[3]**	alone or ×2 only ${}^6P_4 \times 2$ or 6! alone M2 ${}^6C_4 \times 2$ or 6! × 2 alone M0M1 only any other × 2 M0M0 or '2520'× $\frac{2}{7}$ M2A0 (eg (ia)21 (ib) $21\times\frac{2}{7} = 6$ M2A0 but if ans is 6, must see wking) cao	or '2520' – $5 \times {}^6P_4$ M2 SC ONLY on ft from (i)(a): if (i)(a) 5! = 120, then (i)(b)4!×2=48 alone M1M0A0 Other SC ${}^5P_3 \times 2$ M2 (from a vowel at each end, ie treat as MR) NOT isw eg $\frac{720}{'2520'} = \frac{2}{7}$ M1M1A0
7	(ii)	(a)	21	B1 **[1]**		

Question			Answer	Marks	Guidance	
7	(ii)	(b)	${}^5C_3$ or $\frac{5!}{3!2!}$ or ${}^5C_5$ seen or 10 seen in num	M1	$\frac{5}{7}\times\frac{4}{6}$ oe seen	Allow ${}^5C_2$ seen BOD
			$\frac{{}^5C_3}{{}^5C_3+{}^5C_5}$ oe	M1	$\frac{5}{7}\times\frac{4}{6}\div(\frac{5}{7}\times\frac{4}{6}+\frac{2}{7}\times\frac{1}{6})$	
			$\frac{10}{11}$ or 0.909 (3 sf)	A1 **[3]**		
8	(i)		1 – 0.1754 alone = 0.825 (3 sfs)	M1 A1 **[2]**	Allow 1– 0.2855 or 0.7145 or 0.715 alone	
8	(ii)	(a)	${}^4C_2 \times 0.7^2 \times 0.3^2$ = $\frac{1323}{5000}$ or 0.265 (3 sf)	M1 A1 **[2]**	All correct	
8	(ii)	(b)	4,4,2 & 4,3,3 only, seen or implied	B1	Both needed	
			$P(Y = 4) = 0.7^4$ (or $\frac{2401}{10000}$ or 0.2401)	M1		
			$P(Y = 3) = 4 \times 0.3 \times 0.7^3$ (or $\frac{1029}{2500}$ or 0.4116)	M1		
			P(4,3,3) = 3 × "0.2401" × "0.4116"^{2} (or 0.122)	M1	ie 3 × their P(4) × (their P(3))^2	if "3×" omitted twice or "3!×" used twice allow M1M0 eg ans 0.0560, 0.0559,0.336, probably B1M1M1M1M0A0 but must see method
			P(4,4,2) = 3 × 0.2401"^{2} × "0.265" (or 0.0458)	M1	ie 3 × (their P(4))^2 × their P(2) ft (ii)(a) For M mks ignore extra combs eg P(4,4,3)	
			P(Tot = 10) = 0.168 (3 sfs)	A1	If B(30, 0.6) <u>clearly</u> being used: Any 5 combs adding to 10 seen B1 P(8) = ${}^{30}C_8\times0.4^{22}\times0.6^8$ or 0.0002 P(9) = ${}^{30}C_9\times0.4^{21}\times0.6^9$ or 0.0007 P(10) = ${}^{30}C_{10}\times0.4^{20}\times0.6^{10}$ or 0.0020 all three correct M2 or two correct M1 No more marks	
				[6]		

Question			Answer	Marks	Guidance	
9	(i)	(a)	Geo stated or implied $0.9^5 \times 0.1$ alone = 0.059(0…) (2 sfs)	M1 M1 A1 **[3]**	eg by $0.9^p \times 0.1$ or $0.1^p \times 0.9$ alone, $p>1$ all correct	
9	(i)	(b)	0.9^5 or 0.59… (NB cf ans to (i)(a)!!) $1 - 0.9^5$ = 0.4095 or 0.410 (3 sfs)	M1 M1 A1 **[3]**	$0.1 + 0.9\times0.1 + \ldots 0.9^4\times0.1$: M2 1 term wrong or omit or extra or 1 – (all terms correct): M1 or $1 - 0.9^6$: M1	M0M0A0 for $0.9^p \times 0.1$
9	(ii)	(a)	$0.05 + 0.95^2\times 0.05$ = $\frac{761}{8000}$ or 0.0951 (3 sfs)	M1 A1 **[2]**	All correct	NB!! $2 \times 0.95 \times 0.05 = 0.095$ M0A0
9	(ii)	(b)	0.05, $0.95^2\times 0.05$, … or $\frac{1}{20}$, $\frac{361}{8000}$, … oe $\frac{0.05}{1-0.95^2}$ or $\frac{0.05}{1-0.9025}$ oe = $\frac{20}{39}$ or 0.513 (3 sfs)	M1 M1 A1 **[3]**	$\geq$ 2 terms. Not nec'y added May be implied by next line or $\frac{0.05}{1-(1-0.5)^2}$ or $\frac{0.05}{2\times0.05-0.05^2}$ or $\frac{1}{1.95}$ oe	or $r = 0.95^2$ stated or implied NB $\frac{0.05}{1-0.5\times0.05} = 0.0513$ M0A0

Note: "(3 sfs)" means "answer which rounds to ... to 3 sfs". If correct ans seen to $\geq$ 3sfs, ISW for later rounding. Penalise over-rounding only once in paper.

"3 sf" means "answer which rounds to … to 3 sf". Penalise over–rounding if no better answer is seen and penalise only once in the paper.

Question			Answer	Marks	Guidance	
1	(i)		$2k + 4k + 6k + 8k = 1$ $k = \frac{1}{20}$ AND $6 \times \frac{1}{20} = \frac{3}{10}$ **AG**	M1 A1 **[2]**	or $2 + 4 + 6 + 8 = 20$ M1 Must see both for A1 or $2k + 4k + 6k + 8k = 20k$ M1 $P(X = 6) = \frac{6k}{20k} = \frac{3}{10}$ A1	Must see correct wk'g for $k = \frac{1}{20}$, otherwise M0A0 NB $k \times 6 = \frac{3}{10} \Rightarrow k = \frac{1}{20}$ M0A0 (even if tested by showing that $k = \frac{1}{20}$ gives $\Sigma p = 1$) Just showing $\frac{1}{10} + \frac{2}{10} + \frac{3}{10} + \frac{4}{10} = 1$ M0A0
1	(ii)		$2 \times \frac{1}{10} + 4 \times \frac{2}{10} + 6 \times \frac{3}{10} + 8 \times \frac{4}{10}$ oe $= 6$ $2^2 \times \frac{1}{10} + 4^2 \times \frac{2}{10} + 6^2 \times \frac{3}{10} + 8^2 \times \frac{4}{10}$ oe (= 10) $-$ '6'^{2} $= 4$	M1 A1 M1 M1 A1 **[5]**	$\geq$ 3 terms correct ft their values of p, dep $\Sigma p = 1$ cao $\geq$ 3 terms correct; ft their values of p; dep $\Sigma p = 1$ ft their values of p; dep +ve result & $\Sigma p = 1$ cao	Allow i.t.o. k for M1 ÷ 4 M0 Allow ito k for M1M1 ÷ 4 M0 NOT $-$ m^2 ÷ 4 $\sqrt{4} = 2$ lose final A1, not ISW, unless labelled sd
2	(i)		$\frac{3}{4} + \frac{1}{4} \times \frac{3}{8}$ $+ \frac{1}{4} \times \frac{5}{8} \times \frac{3}{16}$ $= \frac{447}{512}$ or 0.873 (3 sf)	M1 M1 A1 **[3]**	$\frac{1}{4} \times \frac{5}{8} \times \frac{13}{16}$ (= $\frac{65}{512}$ or 0.127) $1 - \frac{1}{4} \times \frac{5}{8} \times \frac{13}{16}$	
2	(ii)		$0.6p$ or equiv seen $0.4 + 0.6p = 0.58$ $p = 0.3$	B1 M1 A1 **[3]**	Tree diag alone insufficient for mark. Or $0.6p = 0.18$. "0.18" alone insufficient	NB $0.6 \times 0.3 = 0.18$ seen at the end is probably a check, not an answer. But if 0.3 seen and 0.18 is very clearly indicated as the ans then B1M1A0

Question			Answer	Marks	Guidance	
3	(i)		$S_{xx} = 8700000 - \frac{7000^2}{6}$ (= 533333) $S_{xy} = 509900 - \frac{7000\times456}{6}$ (= –22100) $b = -\frac{"22100"}{"533333"}$ or $-\frac{663}{16000}$ (= –0.0414) $y - \frac{456}{6} =$ "–0.0414"$(x - \frac{7000}{6})$ $y = –0.0414x + 124$ (3 sf)	M1 M1 M1 A1 **[4]**	Correct subst'n in any correct *S* formula Correct subst'n in any correct *b* formula from two correct *S* formulae ft their *b* except if using *r* or $y = -\frac{663}{16000}x + \frac{3979}{32}$ or $y = –0.041x+124$	or $a = \frac{456}{6} -$ ("–0.0414")$\times \frac{7000}{6}$ oe ft "*b*" Allow y=–0.04x+124 if –0.041… seen above
3	(ii)		70 to 72	B1 **[1]**	or 71 per thousand, NOT 71000	No ft from **(i)** Ignore method
3	(iii)		Extrapolation oe Corr'n not high or small sample	B1 B1 **[2]**	Allow "2400 is beyond graph" } "Not shown on the graph" or }1st B1 only "Line drops low, or below 0" } "Outlier" } Poor corr'n oe, or pts not close to line oe 2nd B1	"Line only allows for countries poorer than Nigeria" 1st B1 Allow "Value for Nigeria is –ve 1st B1 NOT "Other factors may apply" oe Ignore all else
3	(iv)		$S_{xx} = 8700000 + 1300^2 - \frac{(7000+1300)^2}{7}$ $S_{yy} = 36262 + 96^2 - \frac{(456+96)^2}{7}$ $S_{xy} = 509900 + 1300\times96 - \frac{8300\times552}{7}$ $r = \frac{"–19814.3"}{\sqrt{"548571"\times"1948.86"}}$ = –0.606 (3 sf)	M1 A1 M1 A1 **[4]**	or $10390000 - \frac{(8300)^2}{7} = \frac{3840000}{7}$ or 548571 or $45478 - \frac{552^2}{7} = \frac{13642}{7}$ or 1948.86 or $634700 - \frac{8300\times552}{7} = -\frac{138700}{7}$ or –19814.3 Correct subst'n in any correct *r* formula from 3 correct subs in 3 correct *S* formulae, ie all correct method	Correct sub in any correct *S* formula M1 Correct value of any *S* seen or implied by *r* A1 SC If n = 6, but otherwise correct allow M1A0M1A0 (ans r = –0.574, must see wking)

Question			Answer	Marks	Guidance	
3	(v)		No effect oe	B1 **[1]**	Stay the same oe Allow just "No"	Ignore all else
4	(i)	(a)	6	B1 **[1]**		
4	(i)	(b)	3×3×3 = 27	M1 A1 **[2]**	3! + 7×3 3 + 3×6 + 6 3! × 4 + 3 Complete correct method. Allow methods equiv to these. Only allow other methods if they appear correct	(Explanation for 3! × 4 + 3: 123: 3!, 112 & 122: 3!, 223 & 233: 3!, 331 & 311: 3! 111, 222, 333: 3 Candidates need not include this)
4	(i)	(c)	**(i)(b)** – 3 If answer is not 24, this method must be explicitly stated in order to give M1A1ft = 24 ft their **(i)(b)**	M1 A1ft **[2]**	or 3! + 6×3 or 3! + 3!×3 or 6 + 3!×3!÷2! or 3! × 4 Complete correct method. Allow methods equiv to these. Only allow other methods if they appear correct	or 8 × 3 (Explanation: there are 8 possible orders starting with 1. Candidates need not include this)
4	(ii)		eg 1123: $\frac{4!}{2!}$ × 3 alone allow M1 for $\frac{4!}{2!}$ × 3! alone eg 1122: $\frac{4!}{2!2!}$ × 3 alone allow M1 for $\frac{4!}{2!2!}$ × 3! alone Total = 54	M2 M2 A1 **[5]**	3! × $^4C_1$ × 3 or 3! × 12 M1 ÷ 2 M1dep (= 36) 3! × $^4C_2$ M1 ÷ 2 M1dep (= 18) Allow methods equiv to these, eg correctly listing cases Only allow other methods if they appear correct. NB 3×3×2×2 = 36 & 3×3×2 × 1 = 18 are incorrect methods unless clear justification given	This method only scores if 3×3×3×3 –…. is used: No. with 4 rep'ns = 3 M1 No. with 3 rep'ns = $\frac{4!}{3!}$ M1 × 6 (= 24) M1 or 8 × 3 M2 81–('3'+'24') or 81–27 M1 (allow 81–3 or 81–24) 18, 36 only score if a correct method seen,, or eg: 18 orders listed starting with "1" or 18 orders listed with two repetitions

Question			Answer	Marks	Guidance	
5			If incorrect p used consistently in all parts of qu 5, no mks in **(i)(a)** & **(b)** but can score M–marks in **(ii)** and **(iii)**.			
5	(i)	(a)	1.25 oe	B1 **[1]**		
5	(i)	(b)	0.8965 – 0.6328 = 0.264 (3 sf)	M1 A1 **[2]**	${}^5C_2(\frac{3}{4})^3(\frac{1}{4})^2$ = $\frac{135}{512}$ or 0.264 (3 sf)	 Answer which rounds to 0.264
5	(ii)		Answer which rounds to 0.244	M1 M1 M1 A1 **[4]**	$((\frac{3}{4})^5)^2$ or $(\frac{243}{1024})^2$ or $(\frac{3}{4})^{10}$ oe (= $\frac{59049}{1048576}$) $(\frac{3}{4})^5\times5(\frac{3}{4})^4(\frac{1}{4})$ or $\frac{243}{1024}\times\frac{405}{1024}$ or $5(\frac{3}{4})^9(\frac{1}{4})$ (= $\frac{98415}{1048576}$) 2×(attempt P(1, 0) alone), (NOT 2×(P(1,0) + P(0,0)) If P(sum ≤ 2), all three M-mks are available, but for 3rd M1, must be 2×(P(1,0)+P(2,0)) only Ans 0.150 probably M1M1M0A0 but check working Ans 0.188 probably M0M1M1A0 but check working	B(10. 0.25) seen or implied M1 Table or formula with n = 10 used M1 P($X \leq 1$) from table or $(\frac{3}{4})^{10} + 10(\frac{3}{4})^9\times(\frac{1}{4})$ M1 0.244 (3 sf) A1 P($X \leq 2$) = 0.526 from table n = 10 M1M1M1A0 SC P(X = 2) answer 0.282: B1
5	(iii)		Use of 0.2637 or 0.264 ${}^{10}C_3 \times (1 - \text{'0.2637'})^7 \times \text{'0.2637'}^3$ = 0.258 (3 sf)	M1 M1 A1 **[3]**	or their **(i)(b)** ft **(i)(b)** allow ft their **(ii)** for this M1 only Correct ans, no working: M1M1A1	SC allow ${}^{10}C_3\times(1-\text{'0.282'})^7\times\text{'0.282'}^3$ M0M1 (0.282 comes from P(3 totals = 2))

Question			Answer	Marks	Guidance	
6	(i)		Attempt find total area, (even if includes a^2) eg $20\times1.4a+10\times3.4a+6\times4.6a+4\times2.6a+10\times3a+30a$ or $28a+34a+27.6a+10.4a+30a+30a$ or $20\times1.4+10\times3.4+6\times4.6+4\times2.6+10\times3+30$ or $28+34+27.6+10.4+30+30$ or $7\times20+17\times10+23\times6$ + …… or $160a$ or 160 or 16 or $16a$ (if area, not ht) 800 ÷ their total (must involve area, not ht) eg $160a = 800$, 800÷ $a = 5$ "Box" ⇒ area. "Square" possibly ⇒ area	M1 M1dep A1 **[3]**	eg tot area = $16cm^2$ or $16a$ M1 800/16 (= 50) M1 $a \times 10 = 50$ $a = 5$ A1 eg tot area = 400 (sqs) M1 800/400 (= 2) M1 $1.4a \times 20 = 70 \times 2$ $a = 5$ A1 Correct ans with nothing incorrect seen: M1M1A1 But where the correct answer clearly results from incorrect working, eg $a = 800/167 = 4.8$ rounded to $a = 5$, then max M1M1A0	Trial methods, eg: $a = 5$ gives $7\times20+17\times10+23\times6$ + …. = 800 M1 But no of apples = 800 M1 Hence $a = 5$ A1 $a = 10$ gives $14\times20+34\times10+46\times6$+. = 1600 M1 But no of apples = 800 M1 Hence $a = 5$ A1 NOT "1cm = 5" (because may just come from counting squares) NB total ht = 16cm so if 16 seen, must clearly be area eg 800/16 may score 0 or 2
6	(ii)		$\frac{1}{2}$ total area or $\frac{1}{2}$ total no. apples ft their 6(i) Median is in 50 – 56 class stated or implied Calculate (approx) $\frac{2}{3}$ of way along class or $\frac{1}{3}$ of way from top of class Median = 53.9 to 54 Not eg 54.2	B1f M1 M1 A1 **[4]**	Correct ans with nothing incorrect seen: M1M1A1 But where the correct answer clearly results from incorrect working, eg $a = 800/167 = 4.8$ rounded to $a = 5$, then max M1M1A0	Examples of correct methods: $400 - (7\times20+17\times10)$ (= 90) $50 + \frac{"90"}{23\times6} \times 6 = 54$ $200 - (70+85)$ (= 45) $50 + \frac{"45"}{69} \times 6 = 54$ $400.5 - (7\times20+17\times10)$ (= 90.5) $50 + \frac{"90.5"}{23\times6} \times 6 = 54$ Use of LB = 49.5: eg median = 49.5 +appr $\frac{2}{3} \times 6 = 53.4$ B1M1A1A0

Question			Answer	Marks	Guidance	
7	(i)		$\Sigma d^2 = n$ seen or implied	M1		Trial method: $\Sigma d^2 = 14$ M1
			$1 - \frac{6\times\text{anything}}{n(n^2-1)} = \frac{63}{65}$ or $\frac{6\times\text{anything}}{n(n^2-1)} = \frac{2}{65}$	M1	eg $1-\frac{6\times\Sigma d^2}{n(n^2-1)}$ or $1-\frac{6\times n^2}{n(n^2-1)}$ or $1-\frac{6\times 1^n}{n(n^2-1)}$ or $1-\frac{6\times 6^2}{n(n^2-1)} = \frac{63}{65}$	$1 - \frac{6\times14}{14(14^2-1)}$ oe M1 $= \frac{63}{65}$ A1 (0.969 : A0)
			$\frac{6}{(n^2-1)} = \frac{2}{65}$ or eg $390 = 2(n^2-1)$	A1 depM2	Any <u>correct</u> eqn after cancelling n or take out factor of n; can be implied by $n = 14$	$\Rightarrow n = 14$ A1 Conclusion needed
			$n = 14$ NOT $n = \pm 14$	A1	But A0 if $n = 14$ clearly follows from incorrect working	
				[4]	If no working or unclear working, but n = 14, M1M1A1A1	
7	(ii)	(a)	$r = 1 \Rightarrow$ st line, hence true (or $r_s = 1$) oe Explanation essential Must state or imply "true"	B1 **[1]**	$r = 1 \Rightarrow y$ incr as x incr, so $r_s = 1$ oe Allow "True because perfect corr'n" or "True because $r = 1$ means pts ranked in order so $r_s = 1$" "$r = 1$ means the ranks will agree" "$r = 1$ means all d's are 0, hence $r_s = 1–0 = 1$"	NOT "r incr so ranks incr" NOT "$r_s = r$ for ranks so true" NOT "True because strong corr'n"
7	(ii)	(b)	Diag, $\geq$ 3 pts, not on st line but with $x_{n+1}>x_n$ & $y_{n+1}>y_n$, Zig zag line or curve, moving up & right	B1	Ignore explan if correct diag given Ignore any st line drawn Allow numerical example for which $r \neq 1$ but $r_s = 1$. If expl'n contradicts diag, mark diag	
			so r_s can still be 1	B1dep	For 2nd B1 must state or imply "false"	
			eg "expon'l curve gives $r \neq 1$ but $r_s = 1$" B1B1	**[2]**		

Question			Answer	Marks	Guidance	
8	(i)	(a)	$0.9^4 \times 0.1$ $= \frac{6561}{100000}$ or 0.0656 (3sf)	M1 A1 **[2]**		
8	(i)	(b)	0.9^5 $= \frac{59049}{100000}$ or 0.59 (2 sf)	M1 A1 **[2]**	Allow 0.9^4 or $1–0.9^5$:M1 but $1–0.9^n$ ($n \neq 5$) or 0.1×0.9^n :M0	$1 – (0.1+0.9\times0.1+0.9^2\times0.1 + \ldots0.9^4\times0.1)$ Allow without "1 –" OR omit last term NB $0.9^5\times0.1 = 0.0590$ M0A0
8	(i)	(c)	0.1×0.1 or $[0.1\times0.1\times0.9 + 0.1\times0.1\times0.1]$ oe $+ 0.1\times0.9\times0.1$ oe $+ 0.9\times0.1\times0.1$ oe $= 0.028$	M1 M1 M1 A1 **[4]**	M1M1 two correct terms, no incorrect multiples M1 all correct Ans 0.027 probably M0M1M1A0 but check working SC if no M-mks scored: SSF, SSS, FSS, SFS or SS, FSS, SFS seen or implied: B1	$3\times0.1^2\times0.9+0.1^3$ no incorrect multiples M2 for 1st term; M1 for 2nd This method only scores using "1 – ": 0.9^3; $3\times0.9^2\times0.1$ no incorrect multiples M1; M1 1 – one or both terms with no further wking: M1(dep M1) eg $1 – 0.9^3$ alone M1M0M1
8	(ii)	(a)	$0.9\times 0.8 \times 0.1$ $= \frac{9}{125}$ or 0.072	M1 A1 **[2]**	alone or allow × 0.8 (ie girls in wrong order) (= 0.0576)	NOT $0.9\times0.8\times0.1\times0.2= 0.0144$: M0A0 NOT $0.9\times0.8\times0.2= 0.144$: M0A0
8	(ii)	(b)	$0.9^{9 \text{ or } 10} \times 0.8^{9 \text{ or } 10} \times 0.1$ (or ×0.2, not ×0.1×0.2) $(0.9 \times 0.8)^9 \times 0.1$ oe $= 5.2\times10^{-3}$ or 0.0052 (2 sf)	M1 M1 A1 **[3]**	allow $0.9^{9 \text{ or } 10} \times 0.8^{9 \text{ or } 10} \times 0.1 \times {}^{18,19,20}C_1$ fully correct SC Consistent use of 0.8 for both girls: **(ii)(a)** 0.128 **(ii)(b)** 0.00360 or 0.9 for both girls: **(ii)(a)** 0.081 **(ii)(b)** 0.0150 If both these ans seen, allow (a) 0 (b) B1	If ans = 0.00360 or 0.0150 see SC below

Note: "(3 sfs)" means "answer which rounds to ... to 3 sfs". If correct ans seen to ≥ 3sfs, ISW for later rounding. Penalise over-rounding only once in paper.

Question			Answer	Marks	Guidance	
1	(i)		2 | 0 4 7 3 | 2 3 4 | 0 5 7 9 5 | 3 5 5 6 8 6 | 2 5 7 9 2 | 4 means 24 or similar	 B1 B1 B1 **[3]**	B1 for stem correct AND (3 branches correct OR 5 branches correct nos but incorrectly ordered) B1 for all correct	Ignore "0" and/or "1" in stem, without leaves Allow incorrect alignment. Allow space instead of line. Allow left–facing diag If all digits are in correct rows and orders, award this mark unless: 4th row is not the longest OR eg a 3rd digit in one row is clearly aligned with a 4th digit in another
1	(ii)		47.6 (3 sf) or $\frac{857}{18}$ or $47\frac{11}{18}$ (cm) oe 51 (cm)	B1 B1ft **[2]**	cao ft wrong diag	eg 857 ÷ 18 = 41.6 B0 but $\frac{857}{18}$ = 41.6 ISW B1
1	(iii)		49 (or 9th no.) becomes 51 or 53 (or 10th no.) becomes 55	B1 B1 **[2]**	No marks for identifying 49 & 53 alone or 51 & 55 alone	NB NO ft from wrong diag NOT eg '51 or higher' Allow embedded answer eg 53 identified as incorrect and state(55+49)÷2=52 scores 2nd B1
2	(i)		5 2 4 1 3 or A B C D E (grades) 3 4 5 2 1 3 1 5 2 4 d^2 4 4 1 1 4 Σd^2 (= 14) $1 - \frac{6\times"14"}{5\times(5^2-1)}$ = 0.3 oe	M1 A1 M1 M1 A1 **[5]**	Attempt ranks Correct ranks; allow both sets reversed Can be implied by eg $\Sigma d^2 = 14$ Attempt Σd^2 dep 1st M1 ft Σd^2 dep 1st M1 If one set reversed, $r_s = -0.3$ M1A0M1M1A0	 One set reversed: A0 Use PMCC on ranks: 1st M1A1 as main scheme then: $\Sigma x = \Sigma y = 15$ $\Sigma x^2 = \Sigma y^2 = 55$ $\Sigma xy = 48$ $S_{xx} = S_{yy} = 10$ $S_{xy} = 3$ allow one arith error M1 $r = 3/\sqrt{(10\times10)}$ allow one arith error M1 = 0.3 A1
2	(ii)		$\Sigma d^2 = 8$ or '2 the same and 2 differ by 2' 1 4 3 2	M1 A1 **[2]**	May be implied	Allow $d^2 = 8$ or similar

Note: "(3 sfs)" means "answer which rounds to ... to 3 sfs". If correct ans seen to ≥ 3sfs, ISW for later rounding. Penalise over-rounding only once in paper.

Question			Answer	Marks	Guidance	
3	(i)		$1\times0.4 + 3\times0.3 + 5\times0.2 + 7\times0.1$ $= 3$ $1^2\times0.4 + 3^2\times0.3 + 5^2\times0.2 + 7^2\times0.1$ $-$ "3"^{2} $= 4$	M1 A1 M1 M1 A1 **[5]**	≥ 3 terms correct ÷ eg 4 M0 ≥ 3 terms correct ÷ eg 4 M0 Dep +ve result	Use of $\Sigma(x - \bar{x})^2\times p$: $2^2\times0.4 + 0 + 2^2\times0.2 + 4^2\times0.1$ M2 or 2 correct non–zero terms M1
3	(ii)		775, 757, 577 $\frac{2}{3}$ or 0.667 (3 sf)	B1 B1 **[2]**	Must show all three	Allow repeats, eg list of 6 orders Alt method X_1: 5 or 7, X_2: 5 or 7; X_3: 5 or 7 or X_1, X_2, X_3 can be 5 or 7 B1
3	(iii)		Binomial stated, or seen or implied with any n & p $^{11}C_4 \times 0.8^7 \times 0.2^4$ $= 0.111$ (3 sf)	B1 M1 A1 **[3]**	eg by $0.8^r \times 0.2^s$ (r,s>1) not just by ^nC_r Correct method Correct answer, no working M1M1A1	NB 0.0388 scores B1M0A0 as it is $^{11}C_5\times0.8^6\times0.8^5$
4	(i)		5.74 0.13 or 'the same'	B1 B1 **[2]**	NB 0.13 seen within working; B0	eg $\frac{\Sigma x^2}{10}$ – (their mean)^2 = 0.13^2 scores B0 for 0.13
4	(ii)		(10×'5.74' + 15×5.6) ÷ 25oe all correct = 5.656 = 5.66 (3 sf)	M1 A1ft **[2]**	eg $5.74\times\frac{2}{5} + 5.6\times\frac{3}{5}$ ft their 5.74	NB (5.74 + 5.6) ÷ 2 = 5.67 M0A0 NB 5.7 with no wking: M0A0 even if already penalised elsewhere for over–rounding
4	(iii)		1st gp (or one gp) is more consistent (or less spread oe) but less accurate (or mean further from true mean oe)	B1ft B1ft **[2]**	2nd gp (or one gp) more accurate or etc but less consistent or etc If neither B1 scored, but state 'consistency does not imply accuracy' or similar: SC B1 Equiv answers accepted, but no others	1st gp (or one gp) more consistent or etc 2nd gp (or the other gp) more accurate or etc Ignore all other, eg ignore 'Claim false' or 'Claim true' etc even if it contradicts other statements Reference to mean of all 25 does not score Follow through their values for 1st gp: eg if 1st gp sd = 5.13: 1st gp less accurate and less consistent oe B1B1 Similar for other ft.

Note: "(3 sfs)" means "answer which rounds to ... to 3 sfs". If correct ans seen to ≥ 3sfs, ISW for later rounding. Penalise over-rounding only once in paper.

Question			Answer	Marks	Guidance	
5	(i)		$S_{xx} = 503.45 - \frac{70.3^2}{10}$ (= 9.241) $S_{yy} = 103.94 - \frac{30.8^2}{10}$ (= 9.076) $S_{xy} = 211.9 - \frac{70.3\times30.8}{10}$ (= -4.624) $r = \frac{"-4.624"}{\sqrt{"9.241"\times"9.076"}}$ = –0.5049…. or –0.505 (3 sfs)	M1 M1 A1 **[3]**	Correct sub in any correct *S* formula Correct sub in any correct *r* formula Correct ans with no wking: M1M1A1	Must be correct sub in all *S*'s & *r* but not nec'y accurate
5	(ii)		Correlation (of UR & CPI) does not imply causation oe or *r* not close to –1	B1 **[1]**	Both (UR & CPI) may depend on another factor or *r* small or poor corr'n oe Ignore all else	Allow One may depend on another factor Allow without context NOT eg UR is independent NOT eg Only for the given years NOT eg Only for certain months
5	(iii)	(a)	$b' = \frac{S_{xy}}{S_{yy}} = \frac{"-4.624"}{"9.076"}$ (= $-\frac{1156}{2269}$ or –0.50948) $x - \frac{70.3}{10} = "-\frac{1156}{2269}"(y - \frac{30.8}{10})$ x = –0.51y + 8.6 (2 sfs) or $x = -\frac{1156}{2269}y + 8.6$	M1 M1 A1 **[3]**	ft their *S*'s or $a' =$ "$-\frac{1156}{2269}$"× ($-\frac{30.8}{10}$) + $\frac{70.3}{10}$ NB use b' (= –0.509), not *r*(= –0.5049)	If *y* on *x*: $b = \frac{S_{xy}}{Sxx} = \frac{"-4.624"}{"9.241"}$ (= –0.500) M1 y–3.08="–0.500"×(x–7.03) or a = 3.08+0.5×7.03 M1 y = –0.50x + 6.6 A0
5	(iii)	(b)	x = –0.509 × 4.0 + 8.60 = 6.56 (3 sf) or 6.6 (2 sf)	M1 A1ft **[2]**	Allow sub y = 0.04 for M1 only ft their equn; ans to 2 sf	If *y* on *x* found in **(a)** 4.0 = –0.500x + 6.60 M1 x = 5.2 (2 sf) A1ft
6			In all three parts of q 6, where the right answer is seen following a method which is unclear, award full marks. If the right answer follows from a method that is very clearly incorrect, award M0A0 in (i) & (iii), and in (ii) award M0M0A0 unless there is a partly correct method worth M1.			
6	(i)		$\frac{1}{5}\times\frac{1}{4}\times 2$ or $\frac{2}{5}\times\frac{1}{4}$ alone oe = $\frac{1}{10}$ or 0.1 oe	M1 A1 **[2]**	or $\frac{^2C_2}{^5C_2}$ or $\frac{1}{^5C_2}$ or $\frac{^2P_2}{^5P_2}$ Allow $^5C_3$ instead of $^5C_2$	Allow M1 for $\frac{1}{5}\times\frac{1}{4}$, but NOT other methods leading to $\frac{1}{20}$ and NOT $\frac{1}{20}$ with no wking M1 for totally correct method except $\frac{1}{5}\times\frac{1}{4}$ seen: M1 NB $\frac{2}{5}\times\frac{1}{4}\times2$ M0A0; $\frac{2}{^5C_2}$ M0A0; $\frac{2}{5}\times\frac{1}{5}$ M0A0

Note: "(3 sfs)" means "answer which rounds to ... to 3 sfs". If correct ans seen to ≥ 3sfs, ISW for later rounding. Penalise over-rounding only once in paper.

Question			Answer	Marks	Guidance	
6	(ii)		$\frac{2}{5}\times\frac{3}{4}\times\frac{2}{3}$ or $\frac{1}{5}\times\frac{3}{4}\times\frac{2}{3}\times2$ oe or $\frac{1}{5}$ or 0.2 (not from incorrect method) or correct list of 6 comb's with 1 vowel or $\frac{2}{...}\times\frac{3}{...}\times\frac{2}{...}\times3$ or $\frac{1}{...}\times\frac{3}{...}\times\frac{2}{...}\times6$	M1	$\frac{2\times {}^3C_2}{.....}$ or $\frac{....}{{}^5C_3}$ or $\frac{6}{.....}$ or $\frac{2}{5}\times\frac{3}{5}\times\frac{3}{5}$	Only if using complement (ie 1–P(0V or 2V)): $\frac{3}{5}\times\frac{2}{4}\times\frac{1}{3}$ OR $\frac{2}{5}\times\frac{3}{4}\times\frac{1}{3}\times3$ M1
			$\frac{1}{5}\times\frac{3}{4}\times\frac{2}{3}\times2\times3$ oe fully correct method	M1	$\frac{2\times {}^3C_2}{{}^5C_3}$ oe or $6\div10$ Allow ${}^5C_2$ instead of ${}^5C_3$. Not P's	$1-(\frac{3}{5}\times\frac{2}{4}\times\frac{1}{3}+\frac{2}{5}\times\frac{3}{4}\times\frac{1}{3}\times3)$ M1 5! or 120 alone is probably an incorrect method in this part
			$=\frac{3}{5}$ or 0.6 oe	A1 **[3]**		See comment before 6(i)
6	(iii)		$1-\frac{1}{{}^5C_4}$ or $1-\frac{1}{5}$ or $\frac{5!-4!}{5!}$ or $\frac{1\times{}^4C_3}{{}^5C_4}$ or $\frac{1}{5}\times4$	M1	or $(\frac{1}{5}\times\frac{4}{4}\times\frac{3}{3}\times\frac{2}{2})+(\frac{4}{5}\times\frac{1}{4}\times\frac{3}{3}\times\frac{2}{2})$ $+(\frac{4}{5}\times\frac{3}{4}\times\frac{1}{3}\times\frac{2}{2})+(\frac{4}{5}\times\frac{3}{4}\times\frac{2}{3}\times\frac{1}{2})$	or $1-\frac{4}{5}\times\frac{3}{4}\times\frac{2}{3}\times\frac{1}{2}$ or $\frac{24+24+24+24}{5!}$
			$=\frac{4}{5}$ or 0.8 oe	A1 **[2]**		$\frac{4}{5}\times\ldots$ M0A0 eg $\frac{4}{5}\times\frac{1}{5}$ M0A0 See comment before 6(i)
7	(i)	(a)	$X\sim B(30, 0.05)$ seen or implied	B1	eg by 0.8122 or 1–0.5535 or $0.95^r\times0.05^s$ (r , $s>1$) Allow B(30,0.95) or B(30, 0.5) for B1 30×0.05 alone insufficient for B1 ${}^nC_r$ insufficient for B1	If $n=15$: B(15, 0.05) B1
			$P(X>2)=1-0.8122$ alone or $1-(0.95^{30}+30\times0.95^{29}\times0.05+{}^{30}C_2\times0.95^{28}\times0.05^2)$	M1		$1-(0.95^{15}+15\times0.95^{14}\times0.05+{}^{15}C_2\times0.95^{13}\times0.05^2)$ M1
			= 0. 1878 or 0.188 (3 sfs)	A1 **[3]**		= 0.0362 A0

Note: "(3 sfs)" means "answer which rounds to ... to 3 sfs". If correct ans seen to ≥ 3sfs, ISW for later rounding. Penalise over-rounding only once in paper.

Question			Answer	Marks	Guidance	
7	(i)	(b)	Addition method: X~B(30,0.05) & Y~B(15,0.05) stated or implied	B1	NB eg 0.0362 implies B(15, 0.05) see below	Subtraction methods: X~B(30,0.05)&Y~B(15,0.05) stated or impl B1
			P(X = 2) = (0.8122–0.5535) or $^{30}C_2\times0.95^{28}\times0.05^2$ or 0.2587/6 OR P($Y \geq 1$) = $(1 - 0.95^{15})$ or 0.5367	M1		P(X=2) = (0.8122–0.5535) or $^{30}C_2\times0.95^{28}\times0.05^2$ or 0.2587/6 OR P(Y =0) = 0.95^{15} or 0.4633 M1
			"0.2587/6" × "0.5367" or 0.1388	M1	fully correct method for P(X=2)×P($Y\geq1$)	fully correct method for P(X=2)×P(Y=0) "0.2587" × "0.4633" or 0.1199/8 M1
			P(X > 2) + P(X = 2) × P($Y \geq 1$) = "0.1878" + "0.1388" alone	M1	[their (a)+any p] alone, but dep 1st M1	1 – (P(X = 0,1) + P(X=2)×P(Y=0)) = 1 – ("0.5535" + "0.1199") OR P($X \geq 2$) – P(X=2)×P(Y=0)) = (1 – "0.5535") – "0.1199" dep 1st M1 M1
			= 0. 327 (3 sf) **AG**	A1	If ans 0.327, check whether it comes from a correct method (possibly not in MS) or clearly comes from an incorrect method eg (0.4465 + 0.2587)× 0.4633 = 0.327 (ie (P($X \geq 2$) + P(X = 2)) × P(Y = 0) B1M1M0M0A0	= 0. 327 (3 sf) **AG** A1
			For A1 must see correct wking or 0.3265/6...			Do not use marks from a mixture of 3rd column and other columns. Decide which column would give most marks and mark according to that method.
				[5]		If n = 15 for both distr's, see next page NB If 0.1392 seen, it comes from given answer – (i)(a) (ie 0.3270 – 0.1878).

Note: "(3 sfs)" means "answer which rounds to ... to 3 sfs". If correct ans seen to $\geq$ 3sfs, ISW for later rounding. Penalise over-rounding only once in paper.

Question			Answer	Marks	Guidance	
7	(i)	**(b)**	Alternative scheme for the case where $n = 15$ is used for both distr's			If $n = 15$ for both distr's: B(15, 0.05) B0 $P(X = 2) = {}^{15}C_2 \times 0.05^2 \times 0.95^{13}$ or 0.1348 OR $P(Y \geq 1) = 1 - 0.95^{15}$ or 0.5367 M1 "0.1348"×"0.5367" or 0.0723 correct method M1 their **(i)(a)** + "0.0732" Dep 1st M1 M1 = 0.1085 A0 NB Also mark subtraction methods if seen.
7	**(ii)**		Any use of 0.327 or their **(i)(b)** for 1st M1 $(1 - 0.327)^3 \times 0.327 + (1 - 0.327)^4 \times 0.327$ Allow "correct" use of their **(i)(a)** or **(i)(b)** for 2nd M1 = 0.167 (3 sf)	M1 M1 A1 **[3]**	$(0.5535 + 0.2586 \times 0.4633)^3 \times 0.327 +$ $(0.5535 + 0.2586 \times 0.4633)^4 \times 0.327$	$1 - 0.673^5 - (1 - 0.673^3)$ oe Allow any use of their **(i)(b)** for 1st M1 then if "correct" use, also 2nd M1 Allow use of their **(i)(a)** in "correct" method for M0M1A0 No marks for use of 0.95 & 0.05
8	**(i)**		12×10×5 (in numerators or alone) OR any prod of 3 probs×6(or ×3! or ${}^3P_3$) $\frac{12}{27} \times \frac{10}{26} \times \frac{5}{25} \times 6$ or $\frac{12 \times 10 \times 5}{{}^{27}C_3}$ = $\frac{8}{39}$ oe or 0.205 (3 sfs)	M1 M1 A1 **[3]**	or ${}^{12}C_1 \times {}^{10}C_1 \times {}^5C_1$ or 600 (in numerators or alone) or eg $(\frac{12}{27} \times \frac{10}{26} \times \frac{5}{25} + \frac{12}{27} \times \frac{5}{26} \times \frac{10}{25}) \times 3$	or $\frac{4}{117}$ or 0.0342 oe Fully correct method Examples: $\frac{12}{27} \times \frac{10}{27} \times \frac{5}{27} \times 6$ or $\frac{12}{25} \times \frac{10}{24} \times \frac{5}{23}$ M1M0A0 or $\frac{1}{27} \times \frac{1}{26} \times \frac{1}{25} \times 6$ M1M0A0

Note: "(3 sfs)" means "answer which rounds to ... to 3 sfs". If correct ans seen to ≥ 3sfs, ISW for later rounding. Penalise over-rounding only once in paper.

Question			Answer	Marks	Guidance		
8	**(ii)**		$0.4 \times \frac{x}{50}$ OR $0.6 \times \frac{50-x}{50}$ oe or $0.4 \times \frac{?}{50}$	M1	$0.4 \times p$ OR $0.6 \times (1-p)$ or similar	$0.4 \times \frac{x}{50}$ or etc	$0.4 \times a$ etc M1
			$0.4 \times \frac{x}{50} + 0.6 \times \frac{50-x}{50} = 0.54$	M1	$0.4 \times p + 0.6 \times (1-p) = 0.54$	$0.4 \times \frac{x}{50} + 0.6 \times \frac{y}{50} = 0.54$ AND $x + y = 50$	$0.4a + 0.6b = 0.54$ AND $a + b = 1$ M1
			$4x = 60$ oe, two terms	A1	$p = 0.3$	$4x = 60$ or $4y = 140$	$a = 0.3$ or $b = 0.7$ A1
			no. of red = 15	A1	no. of red = 15	no. of red = 15	no. of red = 15 A1
			T & I: $0.4 \times \frac{x}{50}$ or etc OR one trial ($n \neq 15$) M1 Trial of $n = 15$ M1A1 Answer stated A1	**[4]**	Allow $x = 15$ as answer, but not if contradicted later If $x \leftrightarrow (50-x)$ or $p \leftrightarrow (1-p)$: similar mks including 1st A1 for $p = 0.7$ or $x = 35$	Correct answer scores full marks unless clearly from incorrect method.	
9			If 0.8 ↔ 0.2 apparently used consistently in 9(i)(a), (i)(b) & possibly (ii). SC; can score all M–marks in all three parts, and A1 in (ii) but A0 in (i)(a) and A0 (i)(b) This may be implied by their answers without working as follows (i)(a) $0.2^{10} \times 0.8 = 8.19 \times 10^{-8}$; $0.2^{9} \times 0.8 = 4.10 \times 10^{-7}$; $0.2^{11} \times 0.8 = 1.64 \times 10^{-8}$ M1A0 (i)(b) $1 - 0.2^{10} = 0.999999898$ M1M1A0; $1 - 0.2^{9} = 0.999999488$ M0M1A0; $1 - 0.2^{11} = 0.999999979$; $0.2^{10} = 1.024 \times 10^{-7}$ M1M0A0 But if 0.9999…. or similar, unclear precisely which method used so M0M0A0 (ii) $1 \div 0.8 = 1.25$ M1A1 **NB!!!!!** Any other p ($\neq$ 0.2 or 0.8) can score only M1 in (ii) & possibly B1ft in (iii)				
9	**(i)**	**(a)**	$0.8^{10} \times 0.2$	M1	Allow $0.8^{9} \times 0.2$ or $0.8^{11} \times 0.2$ or 0.0268 or 0.0172		
			= 0.0215 (3 sf)	A1 **[2]**		If 0.8 ↔ 0.2, see above	
9	**(i)**	**(b)**	0.8^{10} or 0.107….	M1	Not $0.8^{10} \times$ …. M0M0 Not just 0.8^{9} or 0.8^{11} M0M0	$0.2 + 0.8 \times 0.2 + \ldots + 0.8^{9} \times 0.2$ (10 terms) M2 Allow M1 for 1 term omitted or extra	
			$1 - 0.8^{10}$ alone	M1	Allow M1 for $1-0.8^{9}$ or $1-0.8^{11}$ alone or 0.866 or 0.914	Allow use of dots as above, for M1 or M2, so long as their 1st & last and one other term seen	
			= 0.893 (3 sf)	A1 **[3]**		If 0.8 ↔ 0.2, see above	

Note: "(3 sfs)" means "answer which rounds to ... to 3 sfs". If correct ans seen to ≥ 3sfs, ISW for later rounding. Penalise over-rounding only once in paper.

Question			Answer	Marks	Guidance	
9	(ii)		$\frac{1}{0.2}$ alone	M1		Allow 1 ÷ their incorrect *p* used in (i)(a)
			= 5	A1 **[2]**	(5, 1) M1A0	Ignore eg "E(*X*) =" If 1 ÷ 0.8 = 1.25, see above
9	(iii)		4 Allow (4, 1)	B1ft **[1]**	or (ii) – 1 or (ii) × 0.8	ft (their (ii)–1, 1)

S1 June 2014 Mark Scheme Final (without introduction)

Note: "(3 sfs)" means "answer which rounds to ... to 3 sfs". If correct ans seen to ≥ 3sfs, ISW for later rounding
Penalise over-rounding only once in paper.

Question			Answer	Marks	Guidance	
1	(i)		Median = 7.45 (m) IQR = 7.75 – 6.7 = 1.05 (m) allow 1.175 or 1.18 NOT 1.3	B1 M1 A1 **[3]**	cao allow 7.775 – 6.6 or 77.5 – 67 or 77.75 – 66 or 7.8 – 6.5 even though this is an incorrect method or 78 – 65 allow 10.5 or 11.75 or 11.8 but only if med = 74.5	These pairs of values only, and subtract, for M1 eg 7.45, 7.75 – 6.7 = 1.05 B1M1A1 7.45, 7.775 – 6.6 = 1.175 B1M1A1 7.45, 7.8 – 6.5 = 1.3 B1M1A0 7.45, 7.7 – 6.5 = 1.2 B1M0A0 7.45, 77.5 – 67 = 10.5 B1M1A0 74.5, 77.5 – 67 = 10.5 B0M1A1 74.5, 7.75 – 6.7 = 10.5 B0M1A1 74.5, 77.75 – 66 = 11.75 B0M1A1 7.45, 78 – 65 = 13 B1M1A0 74.5, 78 – 65 = 13 B0M1A0 74.5, 77 – 65 = 12 B0M0A0
1	(ii)		4 2 2 | 5 5 3 3 0 | 6 8 7 7 | 6 4 3 2 | 7 6 5 | 7 8 5 | 8 Complete correct diag including order and	 B1* B1dep	 correct digits in correct leaves, ignore order, allow one omitted or extra or misplaced or incorrect digit key: eg 8|6|4 means 6.8 (*B*) and 6.4 (*A*)	Allow a separate diag with leaves to left of stem. If only a separate diag is drawn, with leaves to right of stem: all correct including order, alignment and key: B1 If all digits are in correct rows and orders,

Question			Answer	Marks	Guidance	
			key and alignment	[2]	allow just 8 | 6 means 6.8 NOT 8 | 6 means 8.6 Allow 8 | 6 means 68, if consistent with (i)	& correct key, award this mark unless EITHER: 1. eg a 2nd digit in one row is clearly aligned with a 3rd digit in another OR 2. 1st, 3rd, 4th & 5th rows are very different lengths, eg because of crossing out and replacement
1	**(iii)**		One correct comment on size: B1. One correct comment on spread or shape: B1. The following are examples only. Ignore any working; mark the statements only. Allow "First set" or "Right" for A, "Second set" or "Left" for B.			
			A higher overall A has more taller trees or fewer shorter A has higher median (mean, ave, medium)	B1	B shorter overall B has fewer taller trees or more shorter B has lower median (mean, ave, medium)	NOT A higher than B NOT B has shorter trees than A Allow just quoting the two medians, even if wrong, so long as med of A is gter than med of B. Similarly if quote IQRs
			B more evenly spread or distributed B more spread out B has larger range or IQR or sd Ranges of both are similar A is nearer to normal A is negatively skewed A has a (unique) mode, or modal class or peak; (B doesn't)	B1	A less evenly spread or distributed A less spread out A has smaller range or IQR or sd Allow A's heights are more consistent Not other comment about skew Ignore any other reference to mode or most common	NOT any reference to outliers NOT any reference to sample size NOT any reference to indiv trees NOT two comments on size NOT two comments on spread eg highest on both is 8.5 B0
				[2]	Ignore all else even if incorrect	
2	**(a)**		$(0^2 \times 0.3) + 2^2 \times 0.4 + 4^2 \times 0.3$	M1	last two terms correct. NOT eg ÷ 6 or ÷ 3	$2^2 \times 0.3 + (0) + 2^2 \times 0.3$ M2 1st or 3rd term correct M1
			-2^2 or -4	M1	allow – (any number)^2, dep +ve result	
			$= 2.4$	A1		÷ 3 M0M0A0
				[3]		
2	**(b)**	**(i)**	$2k + 3k + 4k + 5k = 1$ oe	B1	or $14k = 1$ oe "= 1" is essential	NOT just $2 + 3 + 4 + 5 = 14$ so $k = \frac{1}{14}$

Question			Answer	Marks	Guidance	
			($k = \frac{1}{14}$ **AG)**	**[1]**		Allow verification, eg stating that $\frac{2}{14} + \frac{3}{14} + \frac{4}{14} + \frac{5}{14} = 1$
2	**(b)**	(ii)	$\frac{2}{14}, \frac{3}{14}, \frac{4}{14}, \frac{5}{14}$ or $\frac{2}{14}, \frac{6}{14}, \frac{12}{14}, \frac{20}{14}$	B1	$\geq$ 3 correct	$2k, 6k, 12k, 20k$ B1
			Σxp	M1	$\geq$ 3 correct terms added	$2k + 6k + 12k + 20k$ or $40k$ M1 ÷ 4 M0A0
			$= \frac{20}{7}$ or $2\frac{6}{7}$ or 2.86 (3 sf) oe, eg $\frac{40}{14}$	A1	SC 1 $\times \frac{1}{14} + 2 \times \frac{2}{14} + 3 \times \frac{3}{14} + 4 \times \frac{4}{14}$ (=2.143) B0M1A0	
				[3]		
3	**(i)**		Use of 5 or 6 instead of 5.5 for last value of x: all M-marks can be scored, but no A-marks. (ans: 5 gives 2.32 and 1.23; 6 gives 2.39 and 1.40) Use of 5 and 6 instead of 5.5 (probably with freqs 19400/2) could lead to correct mean M1A1, but possibly M1M1A0 for sd.			
			$\frac{\Sigma fx}{\Sigma f}$ attempted $(= \frac{662000}{280900})$	M1	3 terms of Σfx correct.. and ÷ Σf Allow incorrect Σf NOT Σx	÷ 5 or ÷ 6 M0A0
			= 2.36 (3 sf)	A1		
			$\frac{\Sigma fx^2}{\Sigma f}$ attempted $(= \frac{2042350}{280900} =$ 7.270737)	M1	3 terms of Σfx^2 correct and ÷ Σf Allow incorrect Σf NOT Σx	$\frac{\Sigma f(x-\bar{x})^2}{\Sigma f}$ 3 terms of num correct and ÷ Σf M2 $(86900\times1.36^2 + 92500\times0.36^2 + 45000\times0.64^2 + 37100\times1.64^2 + 19400\times3.1^2)$, $(\frac{482210.64}{280900})$ 2 terms of num correct and ÷ Σf M1 Allow incorrect Σf but NOT if $\Sigma f = \Sigma x$ NB √ not requ'd for M1M1
			– "2.36"^{2} (= 1.70 to 1.72, 3 sf)	M1	dep +ve result ÷ 5 or ÷ 6 M0M0A0	
			s.d. = 1.31 or 1.30 (3 sf)	A1	allow 1.3	Correct answer(s) without working score full marks
				[5]		

Question			Answer	Marks	Guidance	
3	(ii)		2 3	B1 B1 **[2]**	allow IQR = 3 – 1 = 2, ie UQ = 3 implied	Ignore working for both, even if Incorrect NB 3, 2 B0B0 unless labelled correctly
4	If $\frac{2}{3}$ is interpreted consistently as 0.6 or 0.66 or 0.67 or 0.7, max marks: (i)(a) M1M1A0 (i)(b) B0 (i)(c) B1ft B1ft (ii) B1M1M1A0					
4	(i)	(a)	Binomial seen or implied 0.6228 – 0.3497 = 0.273 (3 sf)	M1 M1 A1 **[3]**	by use of table or ${}^9C_6$ or $(\frac{2}{3})^p(\frac{1}{3})^q$ $(p + q = 9)$ ${}^9C_6(\frac{1}{3})^3(\frac{2}{3})^6$ $\frac{1792}{6561}$	Eg 0.6228 seen
4	(i)	(b)	0.3497 or 0.350 (3 sf)	B1 **[1]**	NB 0.3498 (from 0.6228 - 0.273) rounds to 0.350 so B1	
4	(i)	(c)	6 2	B1ft B1ft **[2]**		NB 2, 6 B0B0 unless labelled correctly
4	(ii)		27 seen B(27, $\frac{2}{3}$) seen or implied ${}^{27}C_{18}(\frac{1}{3})^9(\frac{2}{3})^{18}$ = 0.161 (3 sf)	B1 M1 M1 A1 **[4]**	not necessarily in a statement or attempt eg $P(X_1 = 1) \times P(X_2 = 8) \times P(X_3 = 9)$, $P(X_1 = 2) \times P(X_2 = 7) \times P(X_3 = 9)$, $P(X_1 = 3) \times P(X_2 = 6) \times P(X_3 = 9)$, etc $\geq$3 sets with $X_1+X_2+X_3=18$ (not nec'y added) M1	NB $P(X_1 = 6) \times P(X_2 = 6) \times P(X_3 = 6)$ $= 0.273^3 = 0.0203$ M0M0A0 $\frac{55}{729}$ (= 0.0754) M0M0A0
5	(i)		$S_{xx} = 20400 - \frac{360^2}{8}$ (= 4200) $S_{yy} = 6.88 - \frac{6.8^2}{8}$ (= 1.1)			

Question			Answer	Marks	Guidance	
			$S_{xy} = 241 - \frac{360\times6.8}{8}$ (= –65)	M1	Correct sub in a correct *S* formula	
			$r = \frac{"-65"}{\sqrt{"4200"\times"1.1"}}$	M1	Correct sub in 3 correct *S* formulae and a correct *r* formula	
			= –0.956 (3 sf)	A1 **[3]**	Correct ans with no working M2A1	Ignore comment about $-1 < r < -0.9$
5	**(ii)**		eg As you move further away, prices drop	B1 **[1]**	High prices go with short distances oe Allow "Strong (or high or good or equiv) neg corr'n between price and distance"	Both variables must be in context ; miles & £ enough Ignore all else, even if incorrect NOT just neg corr'n between price & dist
5	**(iii)**		None	B1 **[1]**		Ignore all else, even if incorrect
5	**(iv)**		$b = \frac{"-65"}{"4200"}$ (= – 0.0154762)	M1	ft their S_{xy} & S_{xx} from (i) for M-marks only	or fresh start correct method
			$Y - \frac{6.8}{8} =$ "– 0.0154762"$(x - \frac{360}{8})$ oe	M1	or $a = \frac{6.8}{8}$ + "0.0154762" × $\frac{360}{8}$ oe	
			$y = -0.0155x + 1.55$ (3 sf) oe or $y = \frac{433}{280} - \frac{13}{840}x$ oe	A1 **[3]**	allow $y = -0.015x + 1.5$ (or figs which round to these) (NOT $y = -0.016x + 1.6$ NOT $y = -0.02x + 1.5$) Correct ans with no working M2A1	Must have "$y =$ " Allow figures in equn which round to the correct figures to either 3 sf or 2 sf, even if they result from arith errors.
5	**(v)**		Values of *x* are chosen beforehand or *x* is independent or controlled	B1 **[1]**	*x* is fixed or given or set or predetermined oe	Not "*x* is constant." Not just "*y* depends on *x*" Ignore all other, even if incorrect
6	**(i)**		6 5 4 3 2 1	B1 **[1]**		
6	**(ii)**		$\Sigma d^2 = 0$ for first 6 teams	M1	May be implied by use of $\Sigma d^2 = 2$	
			$\Sigma d^2 = 2$	B1		
			$1 - \frac{6\sum d^2}{8(8^2-1)}$	M1	ft their Σd^2 ($\neq 0$)	using ranks from (i) can score 2nd M1 only

Question			Answer	Marks	Guidance	
			$= \frac{41}{42}$ or 0.976 (3 sf)	A1 **[4]**		
7	**(i)**		$\frac{n}{n+45} = \frac{5}{8}$ or $n : 45 = 5 : 3$ or $\frac{3}{8} : 45 = \frac{5}{8} : n$ $n = 75$	M1 A1 **[2]**	$\frac{3F}{8} = 45$ & $n = \frac{5}{8} \times F$; $45 \times \frac{8}{3} - 45$; $45 \times \frac{8}{3} \times \frac{5}{8}$	correct first step involving n or complete correct method for finding n
	(ii)		$\frac{45+"75"+52}{45+"75"+52+78}$ alone oe $= \frac{86}{125}$ or $\frac{172}{250}$ or 0.688 (3 sf) oe	M1 A1ft **[2]**	1 - $\frac{78}{45+"75"+52+78}$ oe or $\frac{"250"-78}{"250"}$ oe Completely correct method ft their integer answer to (i) eg if their (i) is 28, ans 0.616 or $\frac{125}{203}$ M1A1ft	$\frac{45+"75"}{"250"} + \frac{52+"75"}{"250"} - \frac{"75"}{"250"}$ or 0.48 + 0.508 – 0.48×0.508
7	**(iii)**	**(a)**	$\frac{10}{25} \times \frac{6}{24}$ or $\frac{6}{25} \times \frac{10}{24}$ seen (or $\frac{2}{5} \times \frac{1}{4}$ or $\frac{6}{25} \times \frac{5}{12}$) oe $(\frac{10}{25} \times \frac{6}{24} + \frac{6}{25} \times \frac{10}{24}$ or $\frac{10}{25} \times \frac{6}{24} \times 2)$ $= \frac{1}{5}$	M1 A1 **[2]**	or $\frac{10}{25} \times \frac{6}{25} + \frac{6}{25} \times \frac{10}{25}$ or $\frac{10}{25} \times \frac{6}{25} \times 2$ oe $\frac{{}^{10}C_1 \times {}^{6}C_1}{{}^{25}C_2}$ oe or $\frac{10 \times 6}{300}$ oe	ie allow M1 if '2×' is omitted **OR** if 25 instead of 24, but not both errors allow M1 for correct num or denom NB long methods <u>may</u> be correct, eg $(\frac{14}{25} \times \frac{10}{14}) \times (\frac{11}{24} \times \frac{6}{11})$ same as $\frac{10}{25} \times \frac{6}{24}$
7	**(iii)**	**(b)**	FA + MC or FC + MA <u>Either</u> $\frac{4}{25} \times \frac{5}{24} \times 2$ <u>or</u> $\frac{10}{25} \times \frac{6}{24} \times 2$ NB ft their (iiia)	M1	Allow $\frac{10}{25} \times \frac{6}{25} \times 2$ or $\frac{4}{25} \times \frac{5}{25} \times 2$ or $\frac{10}{25} \times \frac{6}{24} + \frac{4}{25} \times \frac{5}{24}$ or $\frac{10}{25} \times \frac{6}{25} + \frac{4}{25} \times \frac{5}{25}$ NB ft their (iii)(a)	ie allow 25 instead of 24 AND allow one case <u>with</u> × 2 or both cases <u>without</u> × 2 ie allow 25 <u>and</u> one of these two errors

Question			Answer	Marks	Guidance	
			$(\frac{4}{25}\times\frac{5}{24}\times 2 + \frac{10}{25}\times\frac{6}{24}\times 2 = \frac{1}{5} + \frac{1}{15})$		$\frac{{}^{10}C_1\times{}^{6}C_1}{{}^{25}C_2} + \frac{{}^{4}C_1\times{}^{5}C_1}{{}^{25}C_2}$ oe or $\frac{60+20}{300}$ oe	cf scheme for (iii)(a) allow M1 if one of these fracts correct NB ${}^{25}C_2$ in denom NOT M1 , cf (iii)(a)
			$= \frac{4}{15}$ or 0.267 (3 sf)	A1 **[2]**	cao	NB see note on long methods in 7(iiia)
8	**(i)**		${}^{5}C_2$ oe seen anywhere or num= 10 alone	M1	$\frac{1}{8}\times\frac{1}{7}\times\frac{5}{6}\times\frac{4}{5}$ or $\frac{20}{1680}$ or $\frac{1}{84}$ oe seen	alone or ×... eg $\frac{2}{8}\times\frac{1}{7}\times\frac{5}{6}\times\frac{4}{5}$ M1
			$\frac{{}^{5}C_2}{{}^{8}C_4}$ oe or $\frac{{}^{5}C_2\times 4!}{{}^{8}P_4}$ oe all correct	M1	$\frac{1}{8}\times\frac{1}{7}\times\frac{5}{6}\times\frac{4}{5}\times{}^{4}C_2\times 2$ or $\frac{1}{8}\times\frac{1}{7}\times\frac{5}{6}\times\frac{4}{5}\times 4!\div 2$ oe or $\frac{1}{8}\times\frac{1}{7}\times\frac{5}{6}\times\frac{4}{5}\times 12$ oe all correct	$\frac{4}{8}\times\frac{3}{7}\times\frac{4}{6}$ oe all correct M2 NB $\frac{\text{incorrect}}{{}^{8}C_4}$ does not score
			$= \frac{1}{7}$ or 0.143 (3 sf)	A1 **[3]**	Correct ans scores M1M1A1 regardless of method.	
8	**(ii)**		6! × 2 alone or 5! × 6 × 2 alone oe	M2	M1 for 6! or 5! × 6 or ${}^{6}P_5$ or 720 seen NB 5! scores M0 unless 5! × 6 or 5! × 12	M1 for 7! × 2 alone NB 7! scores M0 unless 7! × 2 alone
			= 1440	A1 **[3]**		
8	**(iii)**		6! × 4 alone or 6! × 2 × 2 alone	M2	M1 for 6! or ${}^{6}P_5$ or 720 seen or 5! × 6 seen but NOT from 5!×3!	5!: M0 unless 5!×6 or 5!×12 or 5!×24
			= 2880	A1 **[3]**		
9	If 0.3 and 0.7 are interchanged consistently through all four parts, all M-marks can be scored, but no A-marks. If 1 – 0.3 is calculated incorrectly (eg 0.6 or 0.66 or $\frac{2}{3}$) consistently, lose the A-mark in (i) but all other marks are available on ft, so long as 0 < ans < 1.					

Question			Answer	Marks	Guidance	
9	(i)		$0.7^4 \times 0.3$ alone = 0.0720 (3 sf) or $\frac{7203}{100000}$ oe	M1 A1 **[2]**	allow 0.072	
9	(ii)		$(0.7 + 0.7^2 + 0.7^3) \times 0.3$ = 0.4599 or 0.460 (3sf) or $\frac{4599}{10000}$ oe	M2 A1 **[3]**	M1 for 1 term omitted, wrong or extra. must add terms, not mult. Allow 0.46	$(1 - 0.7^4) - 0.3$ or $0.7599 - 0.3$ M2 $(1 - 0.7^4) - ...$ or $1 - 0.3 - ...$ M1 $0.7599 - ...$ or $0.7 - ...$ M1 Just $1 - 0.7^4$ or $1 - 0.3$: M0 $(1+ 0.7 + 0.7^2 + 0.7^3)\times 0.3 - 0.3$ M2 1 term omitted, wrong or extra M1
9	(iii)		$1 - 0.7^6$ = 0.882 (3 sf)	M2 A1 **[3]**	M1 for 0.7^6 alone or $1 - 0.7^5$ (= 0.832) or $1 - 0.7^7$ (= 0.918)	$0.3(1+0.7+0.7^2+0.7^3+0.7^4+0.7^5)$ M2 or (ii) + $0.3(1 + 0.7^4 + 0.7^5)$ M2 or (i) + (ii) + $0.3(1 + 0.7^5)$ M2 one term omitted or extra: M1 must add terms, not mult. NB ans 0.832 might be M1M0A0 from omitting last term. Could be, eg, their (ii) + $0.3(1 + 0.7^4)$ correct working, but subtr from 1: M1
9	(iv)		$(1 - \text{“0.882”})^2 \times \text{“0.882”}$ oe = 0.0122 (3 sf)	M1 A1ft **[2]**	or $(0.7^6)^2 \times (1 - 0.7^6)$ or $0.1176^2 \times (1 - 0.1176)$ or $(0.7^6)^2 \times$ their "0.882" or $0.3(0.7^{12} + (0.7^{13}+0.7^{14}+ \ldots + 0.7^{17}))$ allow 0.0123	Not $0.7^2 \times 0.3$ Completely correct method ft their "0.882" except if 0.3 or 0.7