1	e.g. $\frac{3}{x+7}\times\frac{2}{x+6}+\frac{4}{x+7}\times\frac{3}{x+6}+\frac{x}{x+7}\times\frac{x-1}{x+6}(=\frac{3}{8})$ or e.g. $\frac{3}{N}\times\frac{2}{N-1}+\frac{4}{N}\times\frac{3}{N-1}+\frac{N-7}{N}\times\frac{N-8}{N-1}(=\frac{3}{8})$ oe		4	M2	for all correct products and intention to add
				(M1	for one correct product)
	$5x^2-47x+18=0$ oe $(x=9)$ or $5N^2-117N+592=0$			M1	Correct quadratic equation
		16		A1	dep on M3
					Total 4 marks

2	(a)		$\frac{3}{10},\frac{7}{12},\frac{5}{12},\frac{7}{12},\frac{5}{12}$	2	B2	B1 for $\frac{3}{10}$ oe B1 for all other correct probabilities 2d.p truncated or rounded (e.g 0.58 or 0.41 or 0.42)
	(b)	$\frac{7}{10}$ x "$\frac{5}{12}$" or "$\frac{3}{10}$" x "$\frac{7}{12}$" oe		3	M1ft	
		$\frac{7}{10}$ x "$\frac{5}{12}$" + "$\frac{3}{10}$" x "$\frac{7}{12}$" oe			M1ft	
			$\frac{56}{120}$ oe		A1	eg $\frac{7}{15}$ or 0.46....(2 dp truncated or rounded)
	(c)	"$\frac{3}{10}$" x "$\frac{5}{12}$" x $x=\frac{3}{100}$ oe		3	M1ft	A correct equation involving the unknown probability
		$x=\frac{3}{100}\div$ "$\frac{15}{120}$" $(=\frac{6}{25})$ oe			M1ft	Isolating or calculating the value of x
			25		A1	Dep on M1
						Total 8 marks

3	eg $\frac{\left(\frac{N+3}{2}\right)}{N}\left(=\frac{N+3}{2N}\right)$	eg where b = number of black pens $\frac{b}{2b-3}$ or $\frac{b}{N}$ and $N=2b-3$ (or $b=\frac{N+3}{2}$)	eg where r = number of red pens $\frac{r+3}{2r+3}$ or $\frac{r+3}{N}$ and $N=2r+3$ (or $r=\frac{N-3}{2}$)	5	M1	for making a correct start by finding the probability of the first pen being black for their method. If in 2 variables, one must also be defined in terms of the other. (any letter may be used for the variable)
	eg $\frac{N+3}{2N}\times\frac{N-3}{2(N-1)}=\frac{9}{35}$	eg $\frac{b}{2b-3}\times\frac{b-3}{2b-4}=\frac{9}{35}$ or $\frac{b}{N}\times\frac{b-3}{N-1}=\frac{9}{35}$	eg $\frac{r+3}{2r+3}\times\frac{r}{2r+2}=\frac{9}{35}$ or $\frac{r+3}{N}\times\frac{r}{N-1}=\frac{9}{35}$ and $N=2r+3$		M1	oe dep on previous M1 for a correct equation for black, red – must be in one variable or if 2 variables, one must be defined in terms of other.
	eg $35(N+3)(N-3)$ $=9(2N(2N-2))$ or $35(N^2-9)=$ $9(4N^2-4N)$	eg $35(b^2-3b)=$ $9(4b^2-14b+12)$	eg $35(r^2+3r)=$ $9(4r^2+10r+6)$		M1	dep on previous marks for a correct equation in one variable with no algebraic fractions – brackets may or may not be expanded
	eg $N^2-36N+315(=0)$	eg $b^2-21b+108(=0)$	eg $r^2-15r+54(=0)$		M1	For correctly rearranging their equation to a 3 term quadratic
	Working must be seen			21, 15	A1	cao dep on M4
						Total 5 marks

4	$\frac{6}{n} \times \frac{5}{n-1}$ or $\frac{n-6}{n} \times \frac{n-7}{n-1}$ oe or $\frac{6}{n} \times \frac{n-6}{n-1}$		6	M1	for red, red or blue, blue This may be seen as part of an equation allow eg $n-6-1$ in place of $n-7$ or for red, blue
	$\frac{6}{n} \times \frac{5}{n-1}$ and $\frac{n-6}{n} \times \frac{n-7}{n-1}$ oe or $2 \times \frac{6}{n} \times \frac{n-6}{n-1}$ oe			M1	for both products, with no other products This may be seen as part of an equation or for red, blue + blue, red
	$\frac{6}{n} \times \frac{5}{n-1} + \frac{n-6}{n} \times \frac{n-7}{n-1} = \frac{9}{17}$ oe or $2 \times \frac{6}{n} \times \frac{n-6}{n-1} = 1 - \frac{9}{17}$ oe			M1	Correct equation or correct equation using the complementary event.
	$2n^2 - 53n + 306 \ (= 0)$ oe			A1	Correct simplification of equation to a 3 term quadratic. eg $8n^2 - 212n + 1224 \ (= 0)$
	$(2n - 17)(n - 18) \ (= 0)$ or $\dfrac{--53 \pm \sqrt{(-53)^2 - 4 \times 2 \times 306}}{2 \times 2}$ or $\left(n - \dfrac{53}{4}\right)^2 - \left(\dfrac{53}{4}\right)^2 + 153 = 0$ oe			M1	For solving **correct** 3 term quadratic equation using any correct method. If factorising, allow brackets which expanded give 2 out of 3 terms correct (if using formula or completing the square allow one sign error and some simplification – allow as far as eg $\dfrac{53 \pm \sqrt{2809 - 2448}}{4}$ or eg $\left(n - \dfrac{53}{4}\right)^2 = \dfrac{361}{16}$ oe or for both correct solutions of the correct quadratic. $n = 18$, $n = 8.5$
		18		A1	cao dep M3 do not award if non-integer solution also given.
					Total 6 marks

5	$\frac{5}{x} \times \frac{(x-4)}{x}$ oe or $\frac{(x-5)}{x} \times \frac{6}{x}$ oe		5	M1	for a correct expression for P(R,G) or P(G,R)
	$\frac{5}{x} \times \frac{(x-4)}{x} + \frac{(x-5)}{x} \times \frac{6}{x}$ oe			M1	for a correct expression for P(R,G) + P(G,R)
	$19x^2 - 352x + 1600 \ (= 0)$ oe or $19x^2 - 352x = -1600$ oe			M1	for a correct equation in the form $ax^2 + bx + c \ (= 0)$ oe or $ax^2 + bx = -c$ oe
	$(x - 8)(19x - 200) \ (= 0)$ **or** $(x =) \dfrac{-352 \pm \sqrt{(-352)^2 - (4 \times 19 \times 1600)}}{2 \times 19}$ or $19\left[\left(x - \dfrac{176}{19}\right)^2 - \left(\dfrac{176}{19}\right)^2\right] + 1600 (= 0)$			M1	for solving their 3-term quadratic equation using any correct method - if factorising, allow brackets which expanded give 2 out of 3 terms correct (if using formula or completing the square allow one sign error and some simplification – allow as far as $\dfrac{352 \pm \sqrt{123904 - 121600}}{38}$ oe or $19\left(x - \dfrac{176}{19}\right)^2 - \dfrac{576}{19} (= 0)$ oe)
		8		A1	cao, dep on M2. Do not award if non-integer solution also given. 8 must come from correct working.
					Total 5 marks

6	(a)		$\dfrac{5}{12}$	2	B1 for first choice correct 0.41(666…) to 2 dp truncated or rounded
			$\dfrac{7}{12},\dfrac{5}{12}$		B1 for second choice correct 0.58(333…) to 2 dp truncated or rounded 0.41(666…) to 2 dp truncated or rounded
	(b)	$"\dfrac{5}{12}"\times\dfrac{5}{12}$ oe		2	M1 ft from their tree diagram 0.58(333…) to 2 dp truncated or rounded
			$\dfrac{25}{144}$		A1 oe 0.17(361111…) to 2 dp truncated or rounded or 17.(361111)% to 2 sf truncated or rounded
	(c)	$\dfrac{7}{12}\times\dfrac{5}{12}\times\dfrac{x}{15}$ oe or $\dfrac{7}{12}\times\dfrac{5}{12}\times y$ or $2\times\dfrac{7}{12}\times\dfrac{5}{12}$ oe		3	M1 for *GRB* or *RGB* or $2\times GR$ or $2\times RG$
		$2\times\dfrac{7}{12}\times\dfrac{5}{12}\times\dfrac{x}{15}=\dfrac{7}{24}$ oe **or** $2\times\dfrac{7}{12}\times\dfrac{5}{12}\times y=\dfrac{7}{24}$ oe **or** $\dfrac{\dfrac{7}{24}}{2\times\dfrac{7}{12}\times\dfrac{5}{12}}\left(=\dfrac{3}{5}\right)$ oe			M1 (ft their tree diagram) for a complete method 0.29(166…) to 2 dp truncated or rounded
			9		A1
					Total 7 marks

7		eg $\dfrac{x+7}{80}=\dfrac{1}{4}$ **or** $4(x+7)=80$ **or** $x+7=20$		4	M1	for setting up a correct equation in terms of *x* only
		eg $x=80\times\dfrac{1}{4}-7\ (=13)$ **or** $4x+28=80$ **and** $x=\dfrac{80-28}{4}\ (=13)$ **or** $x=13$			M1	for a complete method to find the value of *x* **or** *x* = 13. Award of this mark implies M2.
		eg $80-("13"+7+"13"-11+3\times"13")(=19)$ **or** $\dfrac{"13"+7+"13"-11+3\times"13"}{80}\left(=\dfrac{61}{80}\right)$			M1	for a method to find the number of yellow counters **or** P(R or B or G)
		Correct answer scores full marks (unless from obvious incorrect working)	$\dfrac{19}{80}$		A1	oe eg accept 0.2375 or 23.75% or 0.237 or 23.7% or 0.238 or 23.8% or 0.24 or 24%
						Total 4 marks

8	(a)	eg $x + 0.15 + 0.5 + y + 0.13 + 0.03 = 1$ oe **or** $x + y = 1 - 0.15 - 0.5 - 0.13 - 0.03$ oe **or** $x + y + 0.81 = 1$ oe **or** $x + y = 1 - 0.81$ oe **or** $1 - 0.15 - 0.5 - 0.13 - 0.03 = 0.19$ oe **or** $1 - 0.81 = 0.19$ oe			2	M1	for setting up an equation in x and y using the sum of probabilities equals 1 **or** for showing that probabilities add up to 1
		Working required		Shown		A1	correctly rearranges to $x + y = 0.19$ (must be shown from a correct method) **or** a clear statement that $x + y = 0.19$
	(b)	$x + y = 0.19$ $3x - y = 0.09$ Adding $(x + 3x = 0.19 + 0.09$ or $4x = 0.28)$ **or** $3x - (0.19 - x) = 0.09$ or $x + 3x - 0.09 = 0.19$	$3x + 3y = 0.57$ $3x - y = 0.09$ Subtracting $(3y - - y = 0.57 - 0.09$ or $4y = 0.48)$ **or** $3(0.19 - y) - y = 0.09$ or $\left(\dfrac{0.09 + y}{3}\right) + y = 0.19$		3	M1	for a correct method to eliminate x or y: coefficients of x or y the same **and** correct operator to eliminate selected variable (condone any one arithmetic error in multiplication) **or** writing x or y in terms of the other variable and correctly substituting (condone missing brackets)
		"0.07" + $y = 0.19$ or $3 \times$ "0.07" $- y = 0.09$ **or** $y = 0.19 -$ "0.07" or $y = 3 \times$ "0.07" $- 0.09$	$3x + 3 \times$ "0.12" $= 0.57$ or $3x -$ "0.12" $= 0.09$ **or** $x = 0.19 -$ "0.12" or $x = \left(\dfrac{0.09 + "0.12"}{3}\right)$			M1	dep on first M1 for a correct method to find other variable by substitution of found variable into one equation **or** for repeating the above method to find the second variable.
		Working required		$x = 0.07$ and $y = 0.12$		A1	oe dep on M1
							Total 5 marks