Extended Mathematics
Topic :Probability
Year :May 2013 -May 2023
Paper -4
Answers

Question 1

(a)	$\frac{3}{10}$ correctly placed	1	Accept 0.3
	$\frac{6}{9}$ and $\frac{3}{9}$ correctly placed	1	Accept 0.667 or better and 0.333 or better
	$\frac{7}{9}$ and $\frac{2}{9}$ correctly placed	1	Accept 0.778 or better and 0.222 or better
(b)	$\frac{42}{90}$ or $\frac{21}{45}$ or $\frac{14}{30}$ or $\frac{7}{15}$	3	**M2** for $\frac{7}{10} \times \frac{3}{9} + \frac{3}{10} \times \frac{7}{9}$ soi by 0.467 or better **or M1** for $\frac{7}{10} \times \frac{3}{9}$ **or** $\frac{3}{10} \times \frac{7}{9}$ soi by 0.233 or better

Question 2

(a)	hat $\frac{5}{8}$, $\frac{3}{8}$ scarf $\frac{2}{3}$ $\frac{1}{3}$ $\frac{1}{6}$ $\frac{5}{6}$	**1** **1** **1**	1 mark per pair in correct place
(b) (i)	$\frac{15}{48}$ oe $\left[\frac{5}{16}\right]$	**2FT**	**FT** *their* $\frac{3}{8} \times \frac{5}{6}$ correctly evaluated **M1** $\frac{3}{8} \times \frac{5}{6}$ FT from *their* tree
(ii)	$\frac{5}{24}$	**2FT**	**FT** *their* $\frac{5}{8} \times \frac{1}{3}$ correctly evaluated **M1** $\frac{5}{8} \times \frac{1}{3}$ FT from *their* tree

(iii)	$\frac{13}{48}$ cao	**2**	**M1** for *their* $\frac{3}{8}\times\frac{1}{6}$ + *their* (b)(ii) soi
(c)	$\frac{170}{240}$ or $\frac{85}{120}$ *or* $\frac{34}{48}$ *or* $\frac{17}{24}$ cao	**3**	**M2** for $1-\frac{5}{8}\times\frac{2}{3}\times\frac{7}{10}$ FT *their* tree or $\frac{3}{8}+\frac{5}{8}\times\frac{1}{3}+\frac{5}{8}\times\frac{2}{3}\times\frac{3}{10}$ oe

Question 3

(i)	White = 8.5, red = 11	**5**	**B3** for $7w + 5(w + 2.5) = 114.5$ or for $7(r - 2.5) + 5r = 114.5$ oe **B1** for 8.5 or 11 or **SC2** for $7w + 5 \times w + 2.5 = 114.5$ leading to 9.33[3…] or **SC1** for $7w + 5 \times w + 2.5 = 114.5$ OR **B1** for $r = w + 2.5$ oe **B1** for $7w + 5r = 114.5$ oe **M1** for elimination of a variable
(ii) (a)	$\frac{42}{132}$ or $\frac{21}{66}$ or $\frac{14}{44}$ or $\frac{7}{22}$ (0.318 or 0.3181 to 0.3182)	**2**	**M1** for $\frac{7}{12}\times\frac{6}{11}$
(ii) (b)	$\frac{70}{132}$ or $\frac{35}{66}$ (0.53[0] or 0.5303…)	**3**	**M2** for $\frac{7}{12}\times\frac{5}{11}+\frac{5}{12}\times\frac{7}{11}$ or $1 -$ *their* (a) $-\frac{5}{12}\times\frac{4}{11}$ or **M1** for $\frac{7}{12}\times\frac{5}{11}$ or $\frac{35}{132}$ or **SC1** for $\frac{70}{144}$ oe from replacement

Question 4

(i)	$\frac{2}{5}$, $\frac{1}{4}$, $\frac{3}{4}$, $\frac{1}{4}$ oe	**2**	**B1** for $\frac{2}{5}$ or both $\frac{1}{4}$s in correct place
(ii)	$\frac{18}{20}$ nfww $\left[\frac{9}{10}\right]$	**3**	**M2 FT** for $1 - \textit{their}\ \frac{2}{5} \times \textit{their}\ \frac{1}{4}$ or $\frac{3}{5} \times \frac{3}{4} + \frac{3}{5} \times \textit{their}\ \frac{1}{4} + \textit{their}\ \frac{2}{5} \times \frac{3}{4}$ oe or **M1 FT** for $\textit{their}\ \frac{2}{5} \times \textit{their}\ \frac{1}{4}$ or $\frac{3}{5} \times \textit{their}\ \frac{1}{4} + \textit{their}\ \frac{2}{5} \times \frac{3}{4}$ oe
(iii)	$\frac{27}{125}$ [0.216]	**2**	**M1** for $\frac{3}{5} \times \frac{3}{5} \times \frac{3}{5}$

Question 5

(a)	**(i)**	$\frac{1}{110}$ oe	**2**	**M1** for $\frac{1}{11} \times \frac{1}{10}$
	(ii)	$\frac{6}{110}$ oe $\left[\frac{3}{55}\right]$	**2**	**M1** for $\frac{3}{11} \times \frac{2}{10}$
	(iii)	$\frac{8}{110}$ oe $\left[\frac{4}{55}\right]$	**2FT**	**FT** *their* **(a)(ii)** + $\frac{2}{11} \times \frac{1}{10}$ correctly evaluated **or M1** *their* **(a)(ii)** + $\frac{2}{11} \times \frac{1}{10}$

(b)	**(i)**	$\frac{6}{990}$ oe	$\left[\frac{1}{165}\right]$	**2**	**M1** for $\frac{3}{11}\times\frac{2}{10}\times\frac{1}{9}$
	(ii)	$\frac{336}{990}$ oe	$\left[\frac{56}{165}\right]$	**2**	**M1** for $\frac{8}{11}\times\frac{7}{10}\times\frac{6}{9}$
	(iii)	$\frac{198}{990}$ oe	$\left[\frac{1}{5}\right]$	**5**	**M4** for $3\left(\frac{3}{11}\times\frac{2}{10}\times\frac{8}{9}\right)+3\left(\frac{2}{11}\times\frac{1}{10}\left[\times\frac{9}{9}\right]\right)$ oe **or M3** for $3\left(\frac{3}{11}\times\frac{2}{10}\times\frac{8}{9}\right)$ *or* $3\left(\frac{2}{11}\times\frac{1}{10}\left[\times\frac{9}{9}\right]\right)$ oe **Or** **M1** for $\frac{3}{11}\times\frac{2}{10}\times\frac{8}{9}$ oe seen **and M1** for $\frac{2}{11}\times\frac{1}{10}\left[\times\frac{9}{9}\right]$ oe seen

Question 6

(a)	**(i)**	$\frac{1}{6}$	**1**	
	(ii)	$\frac{4}{6}$ oe	**1**	
	(iii)	$\frac{2}{6}$ oe	**1**	
(b)		$\frac{16}{36}$ oe	**3**	**M2** $\frac{2}{6}\times\frac{4}{6}+\frac{4}{6}\times\frac{2}{6}$ only oe **or M1** for one of $\frac{2}{6}\times\frac{4}{6}$ or $\frac{4}{6}\times\frac{2}{6}$ soi by $\frac{2}{9}$
(c)		$\frac{48}{360}$ oe	**3**	**M2** for $\frac{4}{6}\times\frac{3}{5}\times\frac{2}{4}\times\frac{2}{3}$ only oe **or M1** for denominators 6, 5, 4, 3 soi in product of four fractions

Question 7

(a)	$\frac{1}{4}, \frac{9}{10}, \frac{1}{3}, \frac{2}{3}$	**3**	**B1** for $\frac{1}{4}$ **B1** for $\frac{9}{10}$ **B1** for $\frac{1}{3}$ **and** $\frac{2}{3}$
(b)	45	**1**	
(c)	$\frac{3}{40}$ oe	**2**	**M1** for $\frac{3}{4} \times \frac{1}{10}$ oe
(d)	$\frac{101}{120}$ oe	**3**	**M2** for $\frac{3}{4} \times \frac{9}{10} + \frac{1}{4} \times \frac{2}{3}$ only
(e)	$\frac{781}{1024}$ oe	**2**	**M1** for $1 - \left(\frac{3}{4}\right)^5$ oe

Question 8

(a)	**(i)**	0.6 oe	**2**	**M1** for 0.2 + 0.4
	(ii)	1500	**1**	
	(iii)	0.03 oe	**2**	**M1** for 0.1 × 0.3
(b)		$\frac{112}{132}$ oe $\frac{28}{33} = 0.848[4\ldots]$	**3**	**M2** for $1 - \frac{5}{12} \times \frac{4}{11}$ or $\frac{7}{12} \times \frac{5}{11} + \frac{5}{12} \times \frac{7}{11} + \frac{7}{12} \times \frac{6}{11}$ or $\frac{7}{12} + \frac{5}{12} \times \frac{7}{11}$

Question 9

(a)	**(i)**	Ariven with comparable form for both shown or difference between the two fractions shown	**1**	Accept probabilities changed to decimals or percentages (to 2sf or better)
	(ii)	$\frac{6}{15}$ oe	**2**	**M1** for $\frac{3}{5} \times \frac{2}{3}$
	(iii)	$\frac{7}{15}$ oe	**3**	**M2** for $\frac{3}{5} \times \frac{1}{3} + \frac{2}{5} \times \frac{2}{3}$ oe $1 - \textit{their}$ **(a)(ii)** $- \frac{2}{5} \times \frac{1}{3}$ or **M1** for $\frac{3}{5} \times \frac{1}{3}$ or $\frac{2}{5} \times \frac{2}{3}$ seen
(b)	**(i)**	Completes tree diagram correctly	**3**	**B2** for 5 values correct or **B1** for 1 value correct
	(ii)	$\frac{126}{350}$ oe $\left[\frac{9}{25}\right]$	**2**	**M1** for $\frac{3}{5} \times \frac{6}{7} \times \frac{7}{10}$

(iii)	$\frac{344}{350}$ oe	**3**	**M2** for $1-their\frac{2}{5}\times their\frac{1}{7}\times their\frac{3}{10}$ oe or $\frac{3}{5}+\frac{2}{5}\times\frac{6}{7}+\frac{2}{5}\times\frac{1}{7}\times\frac{7}{10}$ **M1** for $their\frac{2}{5}\times their\frac{1}{7}\times their\frac{3}{10}$ oe or identifies the 7 routes or attempt to add 7 probabilities with at least 5 correct $\frac{9}{25}+\frac{27}{175}+\frac{3}{50}+\frac{9}{350}+\frac{6}{25}+\frac{18}{175}+\frac{1}{25}$ oe

Question 10

(a) (i)	$\frac{1}{36}$ **final answer**	**2**	**M1** for $\frac{1}{6}\times\frac{1}{6}$
(ii)	$\frac{1}{12}$ **final answer**	**3**	**M2** for $3\left(\frac{1}{6}\times\frac{1}{6}\right)$ oe or **M1** for identifying 3 correct pairs (4, 6), (6, 4) and (5, 5)
(b)	7	**1**	
	Refers to most combinations oe	**1**	**Dependent** on previous mark
(c)	$\frac{141}{1296}$ oe $\left[\frac{47}{432}\right]$	**5**	**M4** for $\frac{2}{36}+\left(\left[1-\frac{3}{36}\right]\times\frac{2}{36}\right)+\left(\frac{1}{36}\times\frac{3}{36}\right)$ oe or **M3** for 2 correct probabilities shown <u>added</u> from those above or **M1** for $\left(1-\frac{3}{36}\right)\times\frac{2}{36}$ seen oe And **M1** for $\frac{1}{36}\times\frac{3}{36}$ seen oe or $\frac{1}{6}\times\frac{1}{6}\times\frac{1}{6}\times\frac{1}{6}$ oe alone or added to a probability not of the form $\frac{n}{36}$

Question 11

(a)	$\frac{4}{15}$		**1**	
(b)	80		**1FT**	FT 300 × *their* **(a)**
(c)	**(i)** $\frac{40}{225}$ oe	$\left[\frac{8}{45}\right]$	**3**	**M2** for $\frac{5}{15}\times\frac{4}{15}\times 2$ oe or **M1** for $\frac{5}{15}\times\frac{4}{15}$
	(ii) $\frac{121}{225}$		**3**	**M2** for $\frac{11}{15}\times\frac{11}{15}$ oe or **M1** for $\frac{11}{15}$ or $1-\frac{4}{15}$ seen
(d)	**(i)** $\frac{108}{210}$ oe	$\left[\frac{18}{35}\right]$	**3**	**M2** for $\frac{6}{15}\times\frac{9}{14}+\frac{9}{15}\times\frac{6}{14}$ oe or **M1** for $\frac{6}{15}\times\frac{9}{14}$ oe or $\frac{9}{15}\times\frac{6}{14}$ oe or $\frac{6}{15}\times\frac{5}{14}$ oe or $\frac{6}{15}\times\frac{4}{14}$ oe
	(ii) $\frac{148}{210}$ oe	$\left[\frac{74}{105}\right]$	**4**	**M3** for $\frac{5}{15}\times\frac{10}{14}+\frac{6}{15}\times\frac{9}{14}+\frac{4}{15}\times\frac{11}{4}$ oe or $1-\frac{5}{15}\times\frac{4}{14}-\frac{6}{15}\times\frac{5}{14}-\frac{4}{15}\times\frac{3}{14}$ or **M2** for equivalent of 2 of above products added together oe or **M1** for one correct relevant product oe

Question 12

(a)	**(i)** $\frac{4}{7}$ oe	**1**	
	(ii) $\frac{6}{7}$ oe	**1**	
	(iii) $\frac{5}{7}$ oe	**1**	

(b)	**(i)**	$\frac{12}{42}$ oe nfww	**2**	**M1** for $\frac{4}{7}\times\frac{3}{6}$
	(ii)	$\frac{28}{42}$ oe nfww	**3**	**M2** for $\frac{4}{7}\times\frac{3}{6}+\frac{2}{7}\times\frac{5}{6}+\frac{1}{7}$ or $1-\frac{4}{7}\times\frac{3}{6}-\frac{2}{7}\times\frac{1}{6}$ oe or **M1** for the sum of two terms of $\frac{4}{7}\times\frac{3}{6}, \frac{2}{7}\times\frac{5}{6}, \frac{1}{7}$
(c)		$\frac{120}{210}$ oe nfww	**2**	**M1** for $\frac{6}{7}\times\frac{5}{6}\times\frac{4}{5}$ or $\left(\frac{4}{7}\times\frac{3}{6}\times\frac{2}{5}\right)+3\left(\frac{4}{7}\times\frac{3}{6}\times\frac{2}{5}\right)+3\left(\frac{4}{7}\times\frac{2}{6}\times\frac{1}{5}\right)$ oe

Question 13

(a)	$\frac{38}{56}$ or $\frac{19}{28}$ oe	**4**	[0.679 or 0.6785 to 0.6786] **M3** for $\frac{4}{8}\times\frac{4}{7}+\frac{3}{8}\times\frac{5}{7}+\frac{1}{8}$ [$\times\frac{7}{7}$] oe
(b)	$\frac{60}{336}$ or $\frac{5}{28}$ oe	**2**	**M1** for $\frac{5}{8}\times\frac{4}{7}\times\frac{3}{6}$ or $\left(\frac{4}{8}\times\frac{3}{7}\times\frac{2}{6}\right)+3\left(\frac{4}{8}\times\frac{1}{7}\times\frac{3}{6}\right)$ oe

Question 14

(a)	**(i)**	0.0025 or $\frac{1}{400}$ oe	**2**	**M1** for 0.05^2 oe
	(ii)	0.9975 or $\frac{399}{400}$ oe	**1FT**	**FT** for 1 – (*their* (a)(i)) oe
(b)		0.171 or 0.1714 to 0.1715 or $\frac{6859}{40\,000}$	**3**	**M2** for $4(0.05\times0.95^3)$ oe **M1** for 0.05×0.95^3 oe seen or for the 4 combinations correctly identified

Question 15

(a)	0.05 oe	**2**	**M1** for 1 – (0.2 + 0.3 + 0.45) oe
(b)	15	**1**	
(c) (i)	0.75 oe	**2**	**M1** for 0.45 + 0.3 oe
(ii)	0.135 oe	**2**	**M1** for 0.45 × 0.3 oe
(iii)	0.12 oe	**3**	**M2** for 2(0.3 × 0.2) oe or **M1** for 0.3 × 0.2 or 0.06 oe nfww
(d)	0.243 oe	**5**	**M4** for 3(0.45 × 0.45 × 0.2) + 3(0.3 × 0.3 × 0.45) oe or **M3** for 3(0.45 × 0.45 × 0.2) **or** 3(0.3 × 0.3 × 0.45) oe or **M2** for 0.45 × 0.45 × 0.2 **and** 0.3 × 0.3 × 0.45 or **M1** for 0.45 × 0.45 × 0.2 **or** 0.3 × 0.3 × 0.45 oe or for identifying the correct 6 outcomes e.g. 10 0 0, 0 0 10, 0 10 0, 5 5 0, 5 0 5, 0 5 5

Question 16

(a)	$\frac{1}{64}$	**2**	**M1** for $\frac{1}{8} \times \frac{1}{8}$
(b)	$\frac{63}{64}$	**1FT**	**FT** 1 – *their* **(a)**
(c)	$\frac{30}{64}$ oe	**2**	**M1** for [2 ×] $\frac{3}{8} \times \frac{5}{8}$ oe
(d)	$\frac{7}{64}$	**3**	**M2** for $\frac{1}{8} \times \frac{1}{8} + \frac{1}{8} \times \frac{3}{8} + \frac{3}{8} \times \frac{1}{8}$ oe
(e)	$\frac{24}{64}$ oe	**3**	**M2** for $\frac{1}{8} \times \frac{7}{8} + \frac{3}{8} \times \frac{4}{8} + \frac{2}{8} \times \frac{2}{8} + \frac{1}{8} \times \frac{1}{8}$ oe or $\frac{7}{8} \times \frac{1}{8} + \frac{6}{8} \times \frac{1}{8} + \frac{4}{8} \times \frac{2}{8} + \frac{1}{8} \times \frac{3}{8}$ oe

Question 17

(a)	**(i)**	$\frac{3}{4}$, $\frac{1}{4}$ $\frac{7}{8}$, $\frac{1}{8}$	**2**	**B1** for any 2 correct
	(ii)	$\frac{21}{32}$ oe	**2**	**M1** for $\frac{7}{8}\times\frac{3}{4}$ oe
	(iii)	$\frac{441}{1024}$ oe	**2FT**	**M1** for $\left(\frac{7}{8}\times\frac{3}{4}\right)^2$ or *their* **((a)(ii))**^{2} oe
(b)		175	**2**	**M1** for $200 \times \frac{7}{8}$
(c)		2400	**2**	**M1** for 1575 ÷ *their***(a)(ii)**

Question 18

(a)		0.7, 0.1 oe correctly placed 0.2, 0.8 oe correctly placed	**1** **1**	
(b)	**(i)**	0.44 nfww oe	**3**	**M2** for 1 – *their* 0.7 × *their* 0.8 or for 0.3 + *their* 0.7 × *their* 0.2 oe or **M1** for *their* 0.7 × *their* 0.8 or for two of 0.3 × 0.9, 0.3 × *their* 0.1, *their* 0.7 × *their* 0.2
	(ii)	110	**1FT**	**FT** 250 × *their* **(b)(i)**
(c)		If late at first two stations then certain to be late at station *C* oe	**1**	Indication of certain event (allow 1 or 100% probability or sure) at third station if late at first two stations

Question 19

(a)	$\frac{1}{8}$ oe	**3**	**M2** for $\frac{1}{2}\left(1-\frac{1}{6}-\frac{1}{4}-\frac{1}{3}\right)$ oe or **M1** for $\frac{1}{6}+\frac{1}{4}+\frac{1}{3}$ seen oe or idea that all sum to 1
(b)	$\frac{7}{12}$ oe	**2**	**M1** for $\frac{1}{3}+\frac{1}{4}$ oe
(c) (i)	$\frac{1}{16}$ oe	**2**	**M1** for $\frac{1}{4}\times\frac{1}{4}$ oe
(ii)	$\frac{2}{24}$ oe	**3**	**M2** for $2\times\frac{1}{6}\times\frac{1}{4}$ oe or **M1** for $\frac{1}{6}\times\frac{1}{4}$ oe
(d)	12	**1**	

Question 20

(a)	$\frac{1}{3}, \frac{6}{7}$ correctly placed	**1**	
	$\frac{4}{7}, \frac{3}{7}$ correctly placed	**1**	
(b)	$\frac{2}{21}$ oe	**2**	**M1** for $\frac{2}{3}\times\frac{1}{7}$
(c)(i)	$\frac{15}{21}$ oe	**3**	**M2** for $\frac{2}{3}\times\frac{6}{7}+\frac{1}{3}\times\frac{3}{7}$ oe or **M1** for $\frac{2}{3}\times\frac{6}{7}$ oe or $\frac{1}{3}\times\frac{3}{7}$ oe seen
(c)(ii)	50	**2FT**	**FT** (70 × *their* **(c)(i)**) rounded up or down to integer **M1** for 70 × *their* **(c)(i)**
(d)	$\frac{10}{243}$ oe	**2**	**M1** for $\frac{2}{3}\times\frac{1}{3}\times\frac{1}{3}\times\frac{1}{3}\times\frac{1}{3}[\times k]$ oe nfww where k is positive integer less than 5

Question 21

(a)	$\frac{5}{6}$	**1**	
(b)	$\frac{4}{36}$ oe	**2**	**M1** for $\frac{2}{6}\times\frac{2}{6}$
(c)	20	**1**	
(d)(i)	Diagram completed correctly x x 3 3 3 9 x x 2 2 2 6 x x 2 2 2 6 x x 2 2 2 6 x x 1 1 1 3	**2**	**B1** for 3 correct columns or for 4 correct rows
(d)(ii)(a)	$\frac{9}{36}$ oe	**1FT**	**FT** *their* **(d)(i)**
(d)(ii)(b)	$\frac{4}{36}$ oe	**1FT**	**FT** *their* **(d)(i)**
(e)	$\frac{512}{7776}$ oe	**2**	**M1** for $\left(\frac{4}{6}\right)^k\times\frac{2}{6}$ oe $k = 3$, 4 or 5 only

Question 22

(a)(i)	$\frac{8}{20}$ oe	**3**	**M2** for $\frac{2}{5}\times\frac{1}{4}+\frac{3}{5}\times\frac{2}{4}$ or **M1** for one of these products OR **M1** for probability tree identifying all 20 outcomes with the correct 8 identified OR **M1** for completed possibility space / 2-way table identifying the 8 possible outcomes out of 20, oe **SC1** for $\frac{13}{25}$ with replacement

(a)(ii)	$\frac{9}{25}$ oe	**3**	**M2** for $\frac{2}{5}\times\frac{3}{5}+\frac{3}{5}\times\frac{1}{5}$ oe or **M1** for one of these products OR **M1** for probability tree identifying all 25 outcomes with the correct 9 identified OR **M1** for completed possibility space / 2-way table identifying the 9 possible outcomes out of 25, oe
(a)(iii)	Jojo and e.g. $\frac{40}{100}>\frac{36}{100}$	**1**	**1FT** *their* **(i)** and **(ii)** dep on being in range 0 to 1
(b)	$\frac{24}{60}$ oe	**3**	**M2** for $\frac{2}{5}\times\frac{3}{4}\times\frac{1}{3}+\frac{3}{5}\times\frac{2}{4}\times\frac{1}{3}+\frac{3}{5}\times\frac{2}{4}\times\frac{2}{3}$ oe or **M1** for any one correct product OR **M1** for 4, 5, 4 and 5, 4, 4 and 5, 5, 4 clearly identified on a tree or in a list

Question 23

(a)	$\frac{5}{8}$ $\frac{3}{8}$ $\frac{1}{6}$ $\frac{5}{6}$ $\frac{7}{10}$ $\frac{3}{10}$	**3**	**B1** for each pair
(b)	$\frac{5}{48}$ oe	**2**	**M1FT** for *their* $\frac{5}{8}\times$ *their* $\frac{1}{6}$
(c)	$\frac{304}{480}$ oe	**3**	**M2** for *their* $\frac{5}{8}\times$ *their* $\frac{5}{6}+$ *their* $\frac{3}{8}\times$ *their* $\frac{3}{10}$ oe or **M1** for *their* $\frac{5}{8}\times$ *their* $\frac{5}{6}$ or *their* $\frac{3}{8}\times$ *their* $\frac{3}{10}$

Question 24

(a)(i)	$\frac{10}{20} \times \frac{9}{19}$ oe	**M2**	**B1** for $\frac{9}{19}$ oe seen
(a)(ii)	$\frac{62}{95}$ oe	**4**	**M3** for $\frac{6}{20} \times \frac{14}{19} + \frac{10}{20} \times \frac{10}{19} + \frac{4}{20} \times \frac{16}{19}$ oe or $1 - \frac{6}{20} \times \frac{5}{19} - \frac{10}{20} \times \frac{9}{19} - \frac{4}{20} \times \frac{3}{19}$ oe or **M2** for the sum of two products of different flavours isw or **M1** for one correct product of different flavours isw
(b)	$\frac{5}{57}$ oe	**3**	**M2** for $N \times \left(\frac{4}{20} \times \frac{3}{19} \times \frac{16}{18}\right) + \frac{4}{20} \times \frac{3}{19} \times \frac{2}{18}$ oe or for $3\left(\frac{4}{20} \times \frac{3}{19} \times \frac{16}{18}\right)$ oe or $1 - \{N \times \left(\frac{4}{20} \times \frac{16}{19} \times \frac{15}{18}\right) + \frac{16}{20} \times \frac{15}{19} \times \frac{14}{18}\}$ oe or **M1** for $\frac{4}{20} \times \frac{3}{19} \times \frac{k}{18}$ oe seen

Question 25

(a)	$\frac{5}{9}$ oe	**1**	
(b)	$\frac{80}{153}$ oe	**3**	**M2** for $2 \times \frac{10}{18} \times \frac{8}{17}$ oe or **M1** for $\frac{10}{18} \times \frac{8}{17}$ oe If 0 scored, **SC1** for $\frac{160}{324}$ oe
(c)	$\frac{11}{51}$ oe	**4**	**M3** for $\frac{10}{18} \times \frac{9}{17} \times \frac{8}{16} + \frac{8}{18} \times \frac{7}{17} \times \frac{6}{16}$ oe or **M2** for $\frac{10}{18} \times \frac{9}{17} \times \frac{8}{16}$ oe or $\frac{8}{18} \times \frac{7}{17} \times \frac{6}{16}$

Question 26

(a)	$1 - r$	**1**	
(b)(i)	$(1 - r)(1.3 - r)$ [= 0.4]	**1**	**FT** *their*(**a**) dep on **(a)** being an expression in r
(b)(ii)	$1.3 - 1.3r - r + r^2$ or better nfww	**M1**	**FT** *their* **(b)(i)**
	$0.9 - 2.3r + r^2$ [= 0] OR $13 - 13r - 10r + 10r^2 = 4$ oe	**M1**	**Strict FT** *their* expansion to a quadratic then equating to 0.4 and then collecting to 3 terms on 'one side' OR **Strict FT** *their* expansion to a quadratic = 0.4 all multiplied by 10
	$10r^2 - 23r + 9 = 0$	**A1**	no errors or omissions seen
(b)(iii)	$(5r - 9)(2r - 1)$ [= 0]	**B2**	or **B2** for e.g. $5r(2r - 1) - 9(2r - 1)$ **and then** $5r - 9 = 0$ **and** $2r - 1 = 0$ or **B1** for $5r(2r - 1) - 9(2r - 1)$ [= 0] or $2r(5r - 9) - 1(5r - 9)$ [= 0] or $(5r + a)(2r + b)$ [= 0] where a, b are integers and $ab = +9$ or $2a + 5b = -23$ If 0 scored, **SC1** for $5r - 9$ **and** $2r - 1$ seen but not in factorised form
	$[r =] \frac{9}{5}$ oe $[r =] \frac{1}{2}$ oe	**B1**	
(b)(iv)	0.8 or $\frac{4}{5}$ oe	**1**	

Question 27

(a)(i)	$\frac{2}{5}$ oe	**2**	**M1** for $\frac{4}{6} \times \frac{3}{5}$
(a)(ii)	$\frac{3}{5}$ oe	**1**	**FT** $1 -$ *their* $\frac{12}{30}$ oe
(b)	$\frac{5}{7}$ oe nfww	**4**	**M3** for $\frac{2}{7} + \frac{5}{7} \times \frac{2}{6} + \frac{5}{7} \times \frac{4}{6} \times \frac{2}{5}$ oe or for $1 - \frac{5}{7} \times \frac{4}{6} \times \frac{3}{5}$ oe or **M1** for each of $\frac{5}{7} \times \frac{2}{6}$ and $\frac{5}{7} \times \frac{4}{6} \times \frac{2}{5}$ oe

Question 28

(a)(i)	$\frac{4}{5}$ oe	**1**	
(a)(ii)	$\frac{4}{5}$ oe	**1**	
(b)(i)	$\frac{6}{20}$ oe nfww	**3**	**M2** for $\frac{1}{5}\times\frac{3}{4}+\frac{3}{5}\times\frac{1}{4}$ oe or $2\times\frac{1}{5}\times\frac{3}{4}$ oe or **M1** for $\frac{1}{5}\times\frac{3}{4}$ alone or $\frac{3}{5}\times\frac{1}{4}$ alone or for answer $\frac{3}{20}$ nfww After 0 scored, **SC1** for answer $\frac{6}{25}$
(b)(ii)	$\frac{8}{20}$ oe nfww	**3**	**M2** for $1-\frac{4}{5}\times\frac{3}{4}$ or $\frac{1}{5}\times1+\frac{4}{5}\times\frac{1}{4}$ oe or $2\times\frac{1}{5}\times1$ or $2\times\frac{1}{5}\times\frac{3}{4}+2\times\frac{1}{5}\times\frac{1}{4}$ or *their* (b)(i) + $2\times\frac{1}{5}\times\frac{1}{4}$ or **M1** for answer $\frac{2\text{ or }4\text{ or }5\text{ or }6\text{ or }7}{20}$ oe nfww After 0 scored, **SC1** for answer $\frac{8}{25}$

Question 29

$\frac{7}{260}$ oe	**2**	**M1** for $\frac{7}{40}\times\frac{6}{39}$ oe
$\frac{14}{95}$ oe	**2**	**FT** *their* Venn diagram **M1** for $\frac{8}{20}\times\frac{7}{19}$

Question 30

(a)(i)	$\frac{1}{3}$ oe	**1**	
(a)(ii)	100	**1**	**FT** *their* **(a)(i)** × 300 to at least 3 sf or rounded to the nearest integer
(b)(i)	$\frac{2}{15}$ oe	**3**	**M2** for $4\times\frac{1}{6}\times\frac{1}{5}$ oe or **M1** for $k\left(\frac{1}{6}\times\frac{1}{5}\right)$ oe or list or indication of 4 correct pairs
(b)(ii)	$\frac{3}{5}$ oe	**3**	**M2** for $1-\frac{4}{6}\times\frac{3}{5}$ or $2\left(\frac{2}{6}\times\frac{4}{5}\right)+\frac{2}{6}\times\frac{1}{5}$ oe or $\frac{2}{6}+\left(\frac{4}{6}\times\frac{2}{5}\right)$ oe or **M1** for $\frac{4}{6}\times\frac{3}{5}$ oe seen or $\frac{2}{6}\times\frac{4}{5}[\times 2]$ oe seen or $\frac{2}{6}\times\frac{1}{5}$ oe seen or correct identification of 18 pairs or space diagram oe

Question 31

(a)(ii)	$\frac{3}{10}$ oe	**2**	**FT** *their* tree diagram **M1** for $\frac{3}{4}\times\frac{2}{5}$
(a)(iii)	$\frac{11}{20}$ oe	**3**	**M2** for $\frac{3}{4}\times\frac{3}{5}+\frac{1}{4}\times\frac{2}{5}$ or **M1** for $\frac{3}{4}\times\frac{3}{5}$ or $\frac{1}{4}\times\frac{2}{5}$

(b)	$\frac{36}{125}$ oe	**3**	**M2** for $\left(\frac{2}{5}\right)^2 \times \frac{3}{5} \times 3$ oe or **M1** for $\left(\frac{2}{5}\right)^2 \times \frac{3}{5}$
(c)	$\frac{3}{28}$ oe	**2**	**M1** for $\frac{3}{4} \times \frac{1}{7}$

Question 32

(a)	0.1	1	
(b)(i)	0.2 oe 0.6, 0.3, 0.1 oe	**2**	**B1** for 0.2 **B1** for 0.6, 0.3, 0.1
(b)(ii)	0.48 oe	**2**	**FT** *their* 0.6 from tree diagram **M1** for $0.8 \times$ *their* 0.6
(b)(iii)	0.28 oe	**3**	**M2** for $0.2 + 0.8 \times 0.1$ oe or **M1** for 0.2 or 0.8×0.1 or $0.8 \times (0.6 + 0.3)$
(c)	0.32 oe	**3**	**M2** for $0.8 \times 0.2 + 0.2 \times 0.8$ oe **M1** for one of these products

Question 33

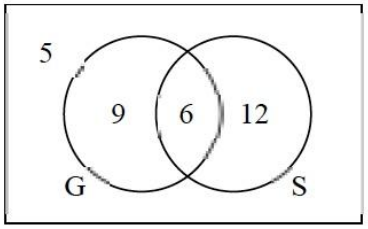
(a)(i)	$\frac{1}{11}$ oe	**1**	
(a)(ii)	$\frac{1}{110}$ oe	**2**	**M1** for $\frac{1}{11} \times \frac{1}{10}$ oe
(a)(iii)	$\frac{4}{55}$ oe	**3**	**M2** for $\left(\frac{2}{11} \times \frac{1}{10}\right) + \left(\frac{3}{11} \times \frac{2}{10}\right)$ oe **or M1** for $\left(\frac{2}{11} \times \frac{1}{10}\right)$ or $\left(\frac{3}{11} \times \frac{2}{10}\right)$ seen oe
(b)(i)	$\frac{1}{165}$ oe	**2**	**M1** for $\frac{3}{11} \times \frac{2}{10} \times \frac{1}{9}$ oe

(b)(ii)	$\frac{1}{5}$ oe	**5**	**M4** for $3\left(\frac{2}{11}\times\frac{1}{10}\times\left[\frac{9}{9}\right]\right)+3\left(\frac{3}{11}\times\frac{2}{10}\times\frac{8}{9}\right)$ oe or **M3** for $3\left(\frac{3}{11}\times\frac{2}{10}\times\frac{8}{9}\right)$ or **M2** for $3\left(\frac{2}{11}\times\frac{1}{10}\times\left[\frac{9}{9}\right]\right)$ or $\frac{3}{11}\times\frac{2}{10}\times\frac{8}{9}$ oe or **M1** for $\frac{2}{11}\times\frac{1}{10}\times\left[\frac{k}{9}\right]$ where k is 3, 6 or 9
(b)(iii)	$\frac{131}{165}$ oe	**2**	**M1** for 1 – (*their* **(b)(i)** + *their* **(b)(ii)**) oe

Question 34

(a)(i)	$\frac{1}{3}$ oe	**1**	
(a)(ii)	0	**1**	
(a)(iii)	$\frac{1}{6}$ oe	**1**	
(b)(i)	$\frac{1}{15}$ oe	**2**	**M1** for $\frac{2}{6}\times\frac{1}{5}$ or equivalent method
(b)(ii)	$\frac{4}{15}$ oe	**3**	**M2** for $\frac{2}{6}\times\frac{1}{5}+\frac{3}{6}\times\frac{2}{5}$ or equivalent method or **M1** for $\frac{2}{6}\times\frac{1}{5}$ oe seen or $\frac{3}{6}\times\frac{2}{5}$ oe seen
(c)	$\frac{7}{18}$ oe	**3**	**M2** for $\left(\frac{1}{6}\right)^2+\left(\frac{2}{6}\right)^2+\left(\frac{3}{6}\right)^2$ oe or **M1** for one correct product seen or sample space with 14 correct pairs identified

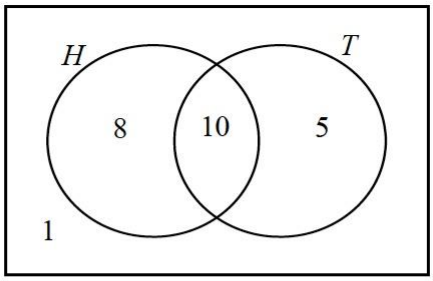
Question 35

(a)(i)		**2**	**B1** for two correct values Or **B1** 5 outside and total in G = 15 and total in S = 18
(a)(ii)	$\frac{3}{8}$ oe	**1**	**FT** $\frac{\textit{their } 12}{32}$
(a)(iii)	$\frac{2}{5}$ oe	**1**	**FT** $\frac{\textit{their } 6}{15}$
9(b)	96	**2**	**M1** for $\frac{36}{64}=\frac{54}{x}$ oe or $36=\frac{54}{(54+b)}\times 100$ oe If 0 scored **SC**1 for answer 150
(c)(i)	$\frac{9}{25}$ oe	**2**	**M1** for $\frac{15}{25}\times\frac{15}{25}$ oe
(c)(ii)	$\frac{16}{25}$ oe	**1**	**FT** 1 – *their* **(c)(i)**
9(d)	$\frac{17}{20}$ oe	**3**	**M2** for $1-\frac{10}{25}\times\frac{9}{24}$ oe or for $\frac{15}{25}\times\frac{14}{24}+\frac{15}{25}\times\frac{8}{24}+\frac{15}{25}\times\frac{2}{24}+\frac{8}{25}\times\frac{15}{24}+\frac{2}{25}\times\frac{15}{24}$ oe or **M1** for one correct relevant product

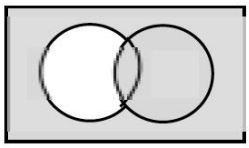
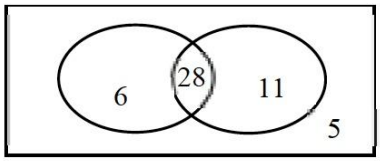
Question 36

(a)	462	**1**	
(b)(i)	$\frac{7}{15}$ oe	**1**	
(b)(ii)	$\frac{7}{15}\times\frac{6}{14}+\frac{6}{15}\times\frac{5}{14}+\frac{2}{15}\times\frac{1}{14}$ $=\frac{37}{105}$	**3**	**M2** for addition of two of $\frac{7}{15}\times\frac{6}{14}+\frac{6}{15}\times\frac{5}{14}+\frac{2}{15}\times\frac{1}{14}$ or **M1** for one of the products seen
b)(iii)	$\frac{29}{65}$ oe	**4**	**M3** for $\frac{7}{15}\times\frac{6}{14}\times\frac{5}{13}+3\times\frac{7}{15}\times\frac{6}{14}\times\frac{6}{13}+3\times\frac{7}{15}\times\frac{6}{14}\times\frac{2}{13}$ oe or $1-3\left(\frac{8}{15}\times\frac{7}{14}\times\frac{7}{13}\right)-\left(\frac{8}{15}\times\frac{7}{14}\times\frac{6}{13}\right)$ oe or **M2** for the sum of at least two of $\frac{7}{15}\times\frac{6}{14}\times\frac{5}{13}$, $N\times\frac{7}{15}\times\frac{6}{14}\times\frac{6}{13}$, $N\times\frac{7}{15}\times\frac{6}{14}\times\frac{2}{13}$ seen or for $\frac{7}{15}\times\frac{6}{14}\times\frac{13}{13}$ or $\frac{7}{15}\times\frac{6}{14}+N\times\frac{7}{15}\times\frac{6}{14}\times\frac{k}{13}$ seen or **M1** for $\frac{7}{15}\times\frac{6}{14}\times\frac{5}{13}$ or $N\times\frac{7}{15}\times\frac{6}{14}\times\frac{6}{13}$ or $N\times\frac{7}{15}\times\frac{6}{14}\times\frac{2}{13}$ seen If 0 scored **SC1** for $\frac{1519}{3375}$ oe

Question 37

(a)		**2**	i.e. 8, 10 and 5 correctly placed **B1** for 10 correctly placed or **M1** for $18 - x$, x and $15 - x$ correctly placed on diagram and $x = 10$ seen
(b)	10	**1**	**FT** *their* Venn diagram
(c)	5	**1**	**FT** *their* Venn diagram
(d)	$\frac{5}{24}$ oe	**1**	**FT** *their* 5 on the Venn diagram
(e)	0	**1**	
(f)	$\frac{5}{17}$ oe	**3**	**M2** for $\frac{their10}{18} \times \frac{their9}{17}$ or **B1FT** for $\frac{their10}{18}$ or $\frac{their9}{17}$ seen After 0 scored, **SC1** for answer $\frac{25}{81}$ oe

Question 38

(a)		**1**	
(b)		**2**	**B1** for 2 or 3 correct elements or **M1** for $34-x$, x and $39-x$ correctly placed on diagram and $x = 28$
(c)(i)	8	**1**	
(c)(ii)	11	**1**	
(c)(iii)	2	**1**	
(c)(iv)	$C \cap S \cap B'$ oe	**1**	
(c)(v)	$\frac{19}{30}$ oe	**1**	
(c)(vi)	$\frac{2}{57}$ oe	**3**	**M2** for $\frac{4}{19} \times \frac{3}{18}$ or **M1** for $\frac{4}{19}$ seen
(c)(vii)	Equal numbers 15 or equal probability $\frac{15}{30}$ oe	**1**	

Question 39

(a)(i)	1	**1**	
(a)(ii)	$\frac{1}{4}$ oe **nfww**	**2**	**M1** for $\frac{2}{4} \times \frac{2}{4}$ oe
(a)(iii)	7	**2**	**M1** for trials with $\left(\frac{3}{4}\right)^k \times \frac{1}{4}$ soi
(b)(i)	0.72 oe	**2**	**M1** for 0.9×0.8
(b)(ii)	0.26 oe	**3**	**M2** for $0.9 \times 0.2 + 0.1 \times 0.8$ or $1 -$ *their* **(b)(i)** $- 0.1 \times 0.2$ or **M1** for 0.9×0.2 or 0.1×0.8 or $1 -$ *their* **(b)(i)** or $1 - 0.1 \times 0.2$

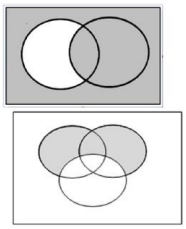
Question 40

(a)(i)	$\frac{1}{6}$ oe on all late branches $\frac{5}{6}$ oe on all not late branches	**2**	**B1** for one correct vertical pair $\frac{1}{6}$ oe and $\frac{5}{6}$ oe
(a)(ii)	$\frac{5}{36}$ oe	**2**	FT *their* tree **M1** for *their* $\frac{1}{6} \times$ *their* $\frac{5}{6}$
(b)(i)	$(G \cup T \cup M)'$ oe	**1**	
(b)(ii)	28	**1**	
(b)(iii)	$\frac{17}{50}$ oe	**1**	
(b)(iv)	$\frac{4}{7}$ oe	**3**	**M2** for $\frac{16}{21} \times \frac{15}{20}$ or **M1** for $\frac{n}{21} \times \frac{n-1}{20}$ or for $\frac{16}{21}$ and $\frac{15}{20}$ seen If 0 scored **SC1** for answer $\frac{256}{441}$ oe

Question 41

$\frac{47}{66}$ oe		**4**	0.712[1…] **M3** for $2\left(\frac{5}{12} \times \frac{4}{11}\right) + 2\left(\frac{4}{12} \times \frac{3}{11}\right) + 2\left(\frac{5}{12} \times \frac{3}{11}\right)$ oe or $1 - \left(\frac{5}{12} \times \frac{4}{11} + \frac{4}{12} \times \frac{3}{11} + \frac{3}{12} \times \frac{2}{11}\right)$ oe or **M2** for sum of 3 or more correct product pairs and no incorrect pairs or for $\frac{5}{12} \times \frac{4}{11} + \frac{4}{12} \times \frac{3}{11} + \frac{3}{12} \times \frac{2}{11}$ and no other pairs or **M1** for $\frac{k}{12} \times \frac{j}{11}$ seen If 0 scored **SC1** for answer $\frac{94}{144}$ oe

Question 42

(a)(i)	$A \cap B$	**1**	
(a)(ii)		**2**	**B1** for each
(b)(i)	$\frac{9}{11}$	**1**	
(b)(ii)	$\frac{36}{121}$ oe	**3**	**M2** for $2\times\frac{2}{11}\times\frac{9}{11}$ oe or **M1** for $\frac{2}{11}\times\frac{9}{11}$ oe If 0 scored **SC1** for $\frac{36}{110}$
(c)(i)	3, 5, 28, 14 correctly placed	**2**	**B1** for 28 in the intersection
(c)(ii)	$\frac{28}{50}$ oe	**1**	**FT** *their* 28 where *their* $28 < 50$
(c)(iii)	$\frac{123}{175}$ oe	**2**	**M1** for $\frac{42}{50}\times\frac{41}{49}$
(c)(iv)	$\frac{63}{88}$ oe	**2**	FT *their* 28 **M1** for $\frac{\textit{their}28}{33}\times\frac{\textit{their}28-1}{32}$

Question 43

(a)(i)	$\frac{1}{15}$ oe	**3**	**M2** for $2\times\frac{1}{6}\times\frac{1}{5}$ oe or **M1** for $\frac{1}{6}\times\frac{1}{5}$ oe or list or indication of 2 correct pairs If 0 scored, **SC1** for answer $\frac{1}{18}$ oe
(a)(ii)	$\frac{7}{15}$ oe	**3**	**M2** for $\left(\frac{4}{6}\times\frac{3}{5}\right)+2\left(\frac{1}{6}\times\frac{1}{5}\right)$ oe or $14\left(\frac{1}{6}\times\frac{1}{5}\right)$ oe or $1-2\left(\frac{2}{6}\times\frac{4}{5}\right)$ or **M1** for $\left(\frac{4}{6}\times\frac{3}{5}\right)$ or $2\left(\frac{1}{6}\times\frac{1}{5}\right)$ oe or $2\left(\frac{2}{6}\times\frac{4}{5}\right)$ or correct identification of 14 pairs If 0 scored, **SC1** for answer $\frac{5}{9}$

'(b)	$\frac{1}{10}$ oe nfww	**4**	**M3** for $6\left(\frac{1}{6}\times\frac{1}{5}\times\frac{1}{4}\right)+6\left(\frac{1}{6}\times\frac{1}{5}\times\frac{1}{4}\right)$ oe or **M2** for $6\left(\frac{1}{6}\times\frac{1}{5}\times\frac{1}{4}\right)$ oe or $2\left(\frac{1}{6}\times\frac{1}{5}\times\frac{1}{4}\right)$oe or **M1** for $k\left(\frac{1}{6}\times\frac{1}{5}\times\frac{1}{4}\right)$ where k is an integer and $1 \leqslant k \leqslant 12$ but not $k = 2$ or $k = 6$ or identifies –2, 2 and 5 or –3, 3 and 5 as the 3 cards needed If 0 scored, **SC1** for answer $\frac{1}{18}$