

Extended Mathematics
Topic :Probability
Year :May 2013 -May 2024
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 $\frac{5}{8}, \frac{3}{8}$	1	1 mark per pair in correct place
	scarf $\frac{2}{3}, \frac{1}{3}$	1	
	$\frac{1}{6}, \frac{5}{6}$	1	
(b) (i)	$\frac{15}{48}$ oe $\left[\frac{5}{16} \right]$	2FT	FT <i>their</i> $\frac{3}{8} \times \frac{5}{6}$ correctly evaluated M1 $\frac{3}{8} \times \frac{5}{6}$ FT from <i>their</i> tree
(ii)	$\frac{5}{24}$	2FT	FT <i>their</i> $\frac{5}{8} \times \frac{1}{3}$ correctly evaluated M1 $\frac{5}{8} \times \frac{1}{3}$ FT from <i>their</i> 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 11.5 = 8.5 + 11
(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)	$\frac{18}{20}$ nfw $\left[\frac{9}{10}\right]$	3	M2 FT for $1 - \text{their } \frac{2}{5} \times \text{their } \frac{1}{4}$ or $\frac{3}{5} \times \frac{3}{4} + \frac{3}{5} \times \text{their } \frac{1}{4} + \text{their } \frac{2}{5} \times \frac{3}{4}$ oe or M1 FT for $\text{their } \frac{2}{5} \times \text{their } \frac{1}{4}$ or $\frac{3}{5} \times \text{their } \frac{1}{4} + \text{their } \frac{2}{5} \times \frac{3}{4}$ 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 <i>their (a)(ii) + $\frac{2}{11} \times \frac{1}{10}$ correctly evaluated</i> or M1 <i>their (a)(ii) + $\frac{2}{11} \times \frac{1}{10}$</i>

(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 $3\left(\frac{3}{11} \times \frac{2}{10} \times \frac{8}{9}\right)$ <i>or</i> $3\left(\frac{2}{11} \times \frac{1}{10} \left[\times \frac{9}{9}\right]\right)$ 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 $\frac{28}{33} = 0.848[4\dots]$	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 $1 - \text{their (a)(ii)} - \frac{2}{5} \times \frac{1}{3}$ 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	<p>M2 for $1 - \text{their } \frac{2}{5} \times \text{their } \frac{1}{7} \times \text{their } \frac{3}{10}$ oe</p> <p>or $\frac{3}{5} + \frac{2}{5} \times \frac{6}{7} + \frac{2}{5} \times \frac{1}{7} \times \frac{7}{10}$</p> <p>M1 for $\text{their } \frac{2}{5} \times \text{their } \frac{1}{7} \times \text{their } \frac{3}{10}$ oe</p> <p>or identifies the 7 routes</p> <p>or attempt to add 7 probabilities with at least 5 correct</p> <p>$\frac{9}{25} + \frac{27}{175} + \frac{3}{50} + \frac{9}{350} + \frac{6}{25} + \frac{18}{175} + \frac{1}{25}$ oe</p>
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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	<p>M2 for $3\left(\frac{1}{6} \times \frac{1}{6}\right)$ oe</p> <p>or M1 for identifying 3 correct pairs (4, 6), (6, 4) and (5, 5)</p>
(b)	7	1	
	Refers to most combinations oe	1	Dependent on previous mark
(c)	$\frac{141}{1296}$ oe $\left[\frac{47}{432}\right]$	5	<p>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</p> <p>or M3 for 2 correct probabilities shown <u>added</u> from those above</p> <p>or M1 for $\left(1 - \frac{3}{36}\right) \times \frac{2}{36}$ seen oe</p> <p>And M1 for $\frac{1}{36} \times \frac{3}{36}$ seen oe</p> <p>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 $\frac{n}{36}$</p>

Question 11

(a)	$\frac{4}{15}$		1	
(b)	80		1FT	FT 300 \times <i>their</i> (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 nfw	2	M1 for $\frac{4}{7} \times \frac{3}{6}$
(ii)	$\frac{28}{42}$ oe nfw	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
(c)	$\frac{120}{210}$ oe nfw	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 $\frac{4}{8} \times \frac{4}{7} + \frac{3}{8} \times \frac{5}{7} + \frac{1}{8} \left[\times \frac{7}{7}\right]$ 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 $4(0.05 \times 0.95^3)$ 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 $2(0.3 \times 0.2)$ oe or M1 for 0.3×0.2 or 0.06 oe nfw
(d)	0.243 oe	5	M4 for $3(0.45 \times 0.45 \times 0.2) + 3(0.3 \times 0.3 \times 0.45)$ oe or M3 for $3(0.45 \times 0.45 \times 0.2)$ or $3(0.3 \times 0.3 \times 0.45)$ oe or M2 for $0.45 \times 0.45 \times 0.2$ and $0.3 \times 0.3 \times 0.45$ or M1 for $0.45 \times 0.45 \times 0.2$ or $0.3 \times 0.3 \times 0.45$ 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 $[2 \times] \frac{3}{8} \times \frac{5}{8}$ 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 <i>their ((a)(ii))²</i> oe
(b)	175	2	M1 for $200 \times \frac{7}{8}$
(c)	2400	2	M1 for $1575 \div \text{their(a)(ii)}$

Question 18

(a)	0.7, 0.1 oe correctly placed 0.2, 0.8 oe correctly placed	1 1	
(b) (i)	0.44 nfwv oe	3	M2 for $1 - \text{their } 0.7 \times \text{their } 0.8$ or for $0.3 + \text{their } 0.7 \times \text{their } 0.2$ oe or M1 for $\text{their } 0.7 \times \text{their } 0.8$ or for two of $0.3 \times 0.9, 0.3 \times \text{their } 0.1,$ $\text{their } 0.7 \times \text{their } 0.2$
(ii)	110	1FT	FT $250 \times \text{their (b)(i)}$
(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 ($70 \times$ their (c)(i)) rounded up or down to integer M1 for $70 \times$ 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 nfw 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 $x \times 3 \ 3 \ 3 \ 9$ $x \times 2 \ 2 \ 2 \ 6$ $x \times 2 \ 2 \ 2 \ 6$ $x \times 2 \ 2 \ 2 \ 6$ $x \times 1 \ 1 \ 1 \ 3$	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
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(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 <i>their</i> (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 <i>their</i> $\frac{5}{8} \times$ <i>their</i> $\frac{1}{6}$
(c)	$\frac{304}{480}$ oe	3	M2 for <i>their</i> $\frac{5}{8} \times$ <i>their</i> $\frac{5}{6} +$ <i>their</i> $\frac{3}{8} \times$ <i>their</i> $\frac{3}{10}$ oe or M1 for <i>their</i> $\frac{5}{8} \times$ <i>their</i> $\frac{5}{6}$ or <i>their</i> $\frac{3}{8} \times$ <i>their</i> $\frac{3}{10}$

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

Question 25

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

Question 26

(a)	$1 - r$	1	
(b)(i)	$(1 - r)(1.3 - r) [= 0.4]$	1	FT <i>their(a)</i> dep on (a) being an expression in r
(b)(ii)	$1.3 - 1.3r - r + r^2$ or better nfw	M1	FT <i>their (b)(i)</i>
	$0.9 - 2.3r + r^2 [= 0]$ OR $13 - 13r - 10r + 10r^2 = 4$ oe	M1	Strict FT <i>their</i> expansion to a quadratic then equating to 0.4 and then collecting to 3 terms on 'one side' OR Strict FT <i>their</i> 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 - <i>their</i> $\frac{12}{30}$ oe
(b)	$\frac{5}{7}$ oe nfw	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 nfw	3	<p>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</p> <p>or M1 for $\frac{1}{5} \times \frac{3}{4}$ alone or $\frac{3}{5} \times \frac{1}{4}$ alone or for answer $\frac{3}{20}$ nfw</p> <p>After 0 scored, SC1 for answer $\frac{6}{25}$</p>
(b)(ii)	$\frac{8}{20}$ oe nfw	3	<p>M2 for $1 - \frac{4}{5} \times \frac{3}{4}$ or $\frac{1}{5} \times 1 + \frac{4}{5} \times \frac{1}{4}$ oe or $2 \times \frac{1}{5} \times 1$</p> <p>or $2 \times \frac{1}{5} \times \frac{3}{4} + 2 \times \frac{1}{5} \times \frac{1}{4}$ or <i>their</i> (b)(i) + $2 \times \frac{1}{5} \times \frac{1}{4}$</p> <p>or M1 for answer $\frac{2 \text{ or } 4 \text{ or } 5 \text{ or } 6 \text{ or } 7}{20}$ oe nfw</p> <p>After 0 scored, SC1 for answer $\frac{8}{25}$</p>

Question 29

$\frac{7}{260}$ oe	2	M1 for $\frac{7}{40} \times \frac{6}{39}$ oe
$\frac{14}{95}$ oe	2	FT <i>their</i> 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 <i>their</i> (a)(i) $\times 300$ 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 <i>their</i> 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 <i>their</i> 0.6 from tree diagram M1 for $0.8 \times$ <i>their</i> 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

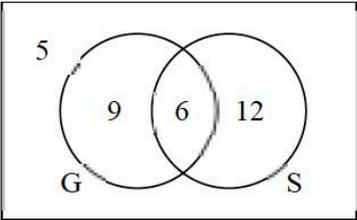
(a)(i)	$\frac{1}{11}$ oe	1	
(a)(ii)	$\frac{1}{110}$ oe	2	M1 for $\frac{1}{11} \times \frac{1}{10}$ oe
(a)(iii)	$\frac{4}{55}$ oe	3	M2 for $\left(\frac{2}{11} \times \frac{1}{10}\right) + \left(\frac{3}{11} \times \frac{2}{10}\right)$ oe or M1 for $\left(\frac{2}{11} \times \frac{1}{10}\right)$ or $\left(\frac{3}{11}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

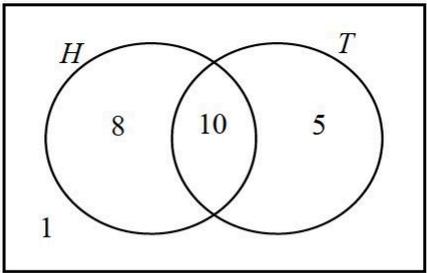
Question 35

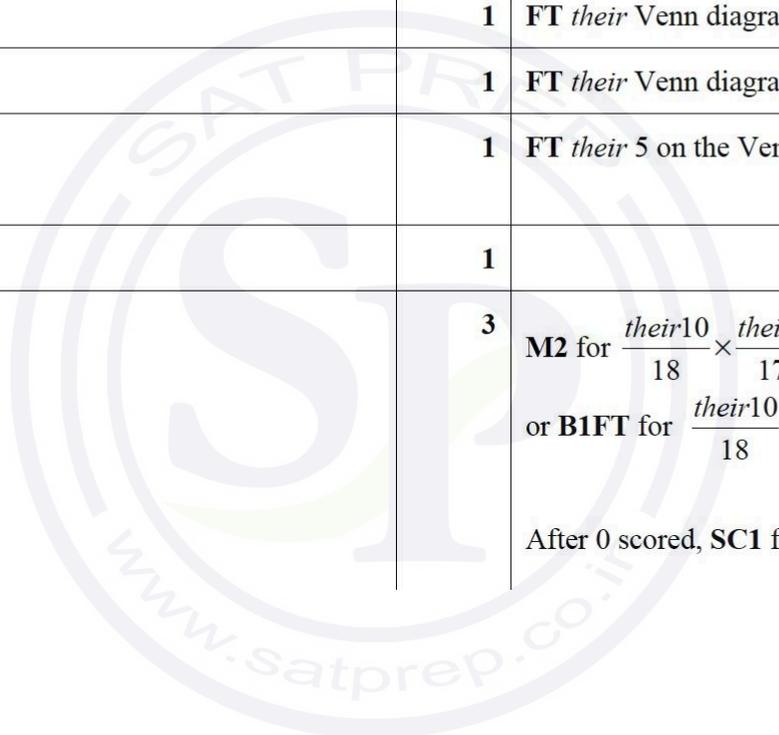
(a)(i)		2	B1 for two correct values Or B1 5 outside and total in G = 15 and total in S = 18
(a)(ii)	$\frac{3}{8}$ oe	1	FT <i>their</i> $\frac{12}{32}$
(a)(iii)	$\frac{2}{5}$ oe	1	FT <i>their</i> $\frac{6}{15}$
9(b)	96	2	M1 for $\frac{36}{64} = \frac{54}{x}$ oe or $36 = \frac{54}{(54+b)} \times 100$ oe If 0 scored SC1 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 – <i>their</i> (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

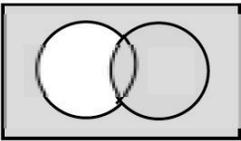
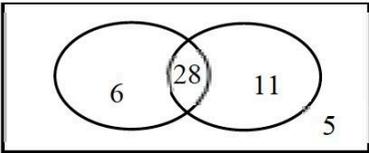
(a)	462	1
(b)(i)	$\frac{7}{15}$ oe	1
(b)(ii)	$\frac{7}{15} \times \frac{6}{14} + \frac{6}{15} \times \frac{5}{14} + \frac{2}{15} \times \frac{1}{14}$ $= \frac{37}{105}$	<p>3 M2 for addition of two of</p> $\frac{7}{15} \times \frac{6}{14} + \frac{6}{15} \times \frac{5}{14} + \frac{2}{15} \times \frac{1}{14}$ <p>or M1 for one of the products seen</p>
b)(iii)	$\frac{29}{65}$ oe	<p>4 M3 for</p> $\frac{7}{15} \times \frac{6}{14} \times \frac{5}{13} + 3 \times \frac{7}{15} \times \frac{6}{14} \times \frac{6}{13} + 3 \times \frac{7}{15} \times \frac{6}{14} \times \frac{2}{13}$ 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)		<p>2 i.e. 8, 10 and 5 correctly placed</p> <p>B1 for 10 correctly placed or M1 for $18 - x$, x and $15 - x$ correctly placed on diagram and $x = 10$ seen</p>
(b)	10	1 FT <i>their</i> Venn diagram
(c)	5	1 FT <i>their</i> Venn diagram
(d)	$\frac{5}{24}$ oe	1 FT <i>their</i> 5 on the Venn diagram
(e)	0	1
(f)	$\frac{5}{17}$ oe	<p>3</p> <p>M2 for $\frac{\text{their}10}{18} \times \frac{\text{their}9}{17}$ or B1FT for $\frac{\text{their}10}{18}$ or $\frac{\text{their}9}{17}$ seen</p> <p>After 0 scored, SC1 for answer $\frac{25}{81}$ oe</p>



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 $1 - \text{their (b)(i)} - 0.1 \times 0.2$ or M1 for 0.9×0.2 or 0.1×0.8 or $1 - \text{their (b)(i)}$ or $1 - 0.1 \times 0.2$

Question 40

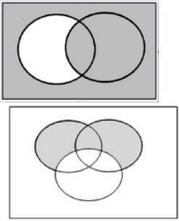
(a)(i)	$\frac{1}{6}$ oe on all late branches $\frac{5}{6}$ oe on all not late branches	2	B1 for one correct vertical pair $\frac{1}{6}$ oe and $\frac{5}{6}$ oe
(a)(ii)	$\frac{5}{36}$ oe	2	FT <i>their</i> tree M1 for <i>their</i> $\frac{1}{6} \times \text{their}$ $\frac{5}{6}$
(b)(i)	$(G \cup T \cup M)'$ 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

$$\frac{47}{66} \text{ oe}$$

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 <i>their</i> 28 where <i>their</i> $28 < 50$
(c)(iii)	$\frac{123}{175}$ oe	2	M1 for $\frac{42}{50} \times \frac{41}{49}$
(c)(iv)	$\frac{63}{88}$ oe	2	FT <i>their</i> 28 M1 for $\frac{\text{their}28}{33} \times \frac{\text{their}28-1}{32}$

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 $\frac{5}{9}$

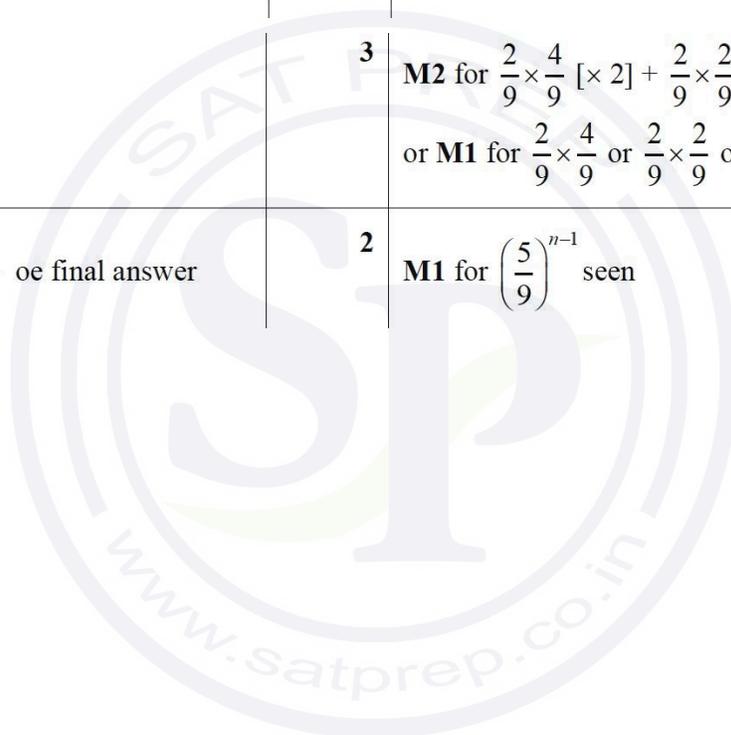
(b)	$\frac{1}{10}$ oe nfw	4	<p>M3 for $6\left(\frac{1}{6} \times \frac{1}{5} \times \frac{1}{4}\right) + 6\left(\frac{1}{6} \times \frac{1}{5} \times \frac{1}{4}\right)$ oe</p> <p>or M2 for $6\left(\frac{1}{6} \times \frac{1}{5} \times \frac{1}{4}\right)$ oe or $2\left(\frac{1}{6} \times \frac{1}{5} \times \frac{1}{4}\right)$ oe</p> <p>or M1 for $k\left(\frac{1}{6} \times \frac{1}{5} \times \frac{1}{4}\right)$ where k is an integer and $1 \leq k \leq 12$ but not $k=2$ or $k=6$</p> <p>or identifies $-2, 2$ and 5 or $-3, 3$ and 5 as the 3 cards needed</p> <p>If 0 scored, SC1 for answer $\frac{1}{18}$</p>
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Question 44

(a)(i)	$\frac{1}{6}$ oe	1	
(a)(ii)	25	1	FT their (a)(i) dep on $0 < \mathbf{(a)} < 1$
(b)(i)	$\frac{11}{36}$ oe	3	<p>M2 for $\frac{1}{6} \times \frac{2}{6} + \frac{3}{6} \times \frac{3}{6}$ oe or correct possibility diagram with 11 outcomes identified</p> <p>or M1 for $\frac{1}{6} \times \frac{2}{6}$ or $\frac{3}{6} \times \frac{3}{6}$ oe</p> <p>or lists the 11 required outcomes or for possibility diagram but required outcomes not indicated</p>
(b)(ii)	$\frac{2}{11}$ oe	2	<p>M1 for $\frac{2}{k}$ or $\frac{p}{\text{their } 11}$ seen oe leading to answer</p>
(c)	6	2	<p>M1 for $\left(\frac{4}{6}\right)^k \times \frac{2}{6} = \frac{32}{729}$ written oe</p> <p>soi by one trial with $k > 1$</p> <p>or $2^{n-1} = 32$ or better</p> <p>or $3^n = 729$ or better</p>

Question 45

(a)(i)	$\frac{2}{5}, \frac{5}{9}, \frac{4}{9}, \frac{5}{9}, \frac{4}{9}$	2	B1 for $\frac{2}{5}$ and a pair of probabilities for spinner B that sum to 1
a(ii)(a)	$\frac{1}{3}$ oe	2	FT dep their tree diagram M1 for $\frac{3}{5} \times$ their $\frac{5}{9}$
a(ii)(b)	$\frac{2}{3}$ oe	1	FT dep $1 -$ their $\frac{1}{3}$
(b)	72	1	
(c)	$\frac{20}{81}$ oe	3	M2 for $\frac{2}{9} \times \frac{4}{9} [\times 2] + \frac{2}{9} \times \frac{2}{9}$ oe or M1 for $\frac{2}{9} \times \frac{4}{9}$ or $\frac{2}{9} \times \frac{2}{9}$ oe
(d)	$\left(\frac{5}{9}\right)^{n-1} [\times] \frac{4}{9}$ oe final answer	2	M1 for $\left(\frac{5}{9}\right)^{n-1}$ seen



Question 46

(a)(i)	0	1	
(a)(ii)	$\frac{1}{7}$ oe	1	
(b)	$\frac{4}{49}$ oe	2	M1 for $\frac{2}{7} \times \frac{2}{7}$
(c)(i)	$\frac{2}{21}$ oe	3	M2 for $\frac{2}{7} \times \frac{1}{6} + \frac{1}{7} \times \frac{2}{6}$ oe or M1 for $\frac{2}{7} \times \frac{1}{6}$ or $\frac{1}{7} \times \frac{2}{6}$ oe seen If 0 scored SC1 for $\frac{4}{49}$
(c)(ii)	$\frac{19}{21}$ oe	3	M2 for $1 - \left(\frac{2}{7} \times \frac{1}{6}\right) - \left(\frac{2}{7} \times \frac{1}{6}\right)$ oe or M1 for $\left(\frac{2}{7} \times \frac{1}{6}\right) + \left(\frac{2}{7} \times \frac{1}{6}\right)$ oe ALTERNATIVE M2 for $\frac{1}{7} [\times 1] \times 3 + \frac{2}{7} \times \frac{5}{6} \times 2$ or M1 for $\frac{2}{7} \times \frac{5}{6}$ or $\frac{1}{7} [\times 1] \times 3$ If 0 scored SC1 for $\frac{38}{49}$
(d)	3	2	M1 for $\frac{5}{7} \times \frac{4}{6} \times \frac{2 \text{ or } 3}{5}$