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EDEXCEL INTERNATIONAL A LEVEL MATHS: QUESTIONS BY TOPIC

Probability (S1.2)

International A Level Mathematics · S1: Statistics 1 (WST01)

25 questions · 246 marks · Mark schemes included

Past papers October 2020 - June 2025 · 2 sub-topics

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 Piccadilly Business Centre, Unit C, Aldow Enterprise Park
Blackett Street, Manchester, M12 6AE

HOW TO USE THIS BOOKLET

Questions are grouped by sub-topic and run from the lowest to the highest mark tariff, then oldest paper first.

Click any row below to jump straight to that sub-topic or question.

On every question page, click ANSWER in the top-right corner to jump to its mark scheme; < QUESTION brings you back.

A gold bar in the left margin marks exactly where the question sits on the original page.

Diagrams, graphs, grids and tables are printed exactly as they appear in the original papers.

Each question is filed under its main topic; longer questions may also test skills from other topics.

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QUESTIONS

25 questions · 246 marks · 2 sub-topics

SUB-TOPIC S1.2a

VENN DIAGRAMS, CONDITIONAL PROBABILITY & INDEPENDENCE

Sub-topic S1.2a · 15 questions · 149 marks · lowest tariff first



4. Two events C and D are such that

$$P(C \cup D) = 0.59 \quad P(D) = 0.45 \quad P(C|D) = 0.2$$

Find the value of

(a) $P(C \cap D)$

(2)

(b) $P(C)$

(2)

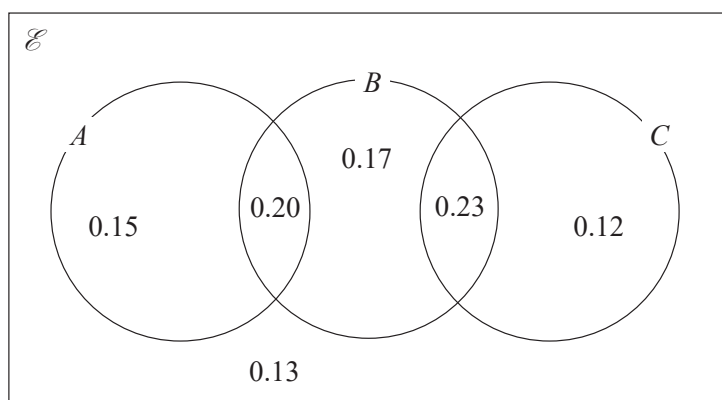
Question 4 continued

(Total for Question 4 is 4 marks)



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1. The Venn diagram shows the events A , B and C and their associated probabilities.



Find

- (a) $P(B')$ (1)
- (b) $P(A \cup C)$ (2)
- (c) $P(A|B')$ (2)

Question 1 continued

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Q1

(Total 5 marks)



Question 1 continued

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Q1

(Total 7 marks)



- Their replies showed that

- 29 read only cooking magazines
- 33 read only travel magazines
- 42 read only sport magazines
- 17 read cooking magazines and sport magazines but **not** travel magazines
- 11 read travel magazines and sport magazines but **not** cooking magazines
- 22 read cooking magazines and travel magazines but **not** sport magazines
- 32 **do not** read cooking magazines, travel magazines or sport magazines

- (3)

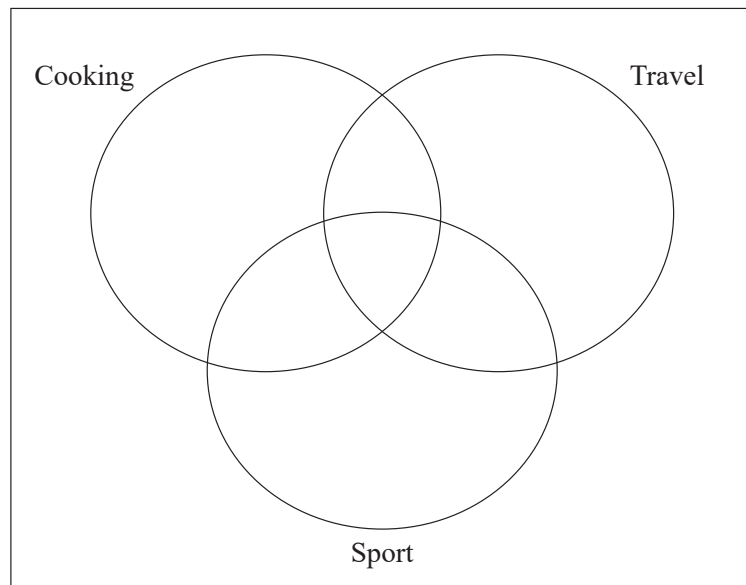
(b) Find the probability that this adult,

- (1)

- (2)

(2)

Question 3 continued



Question 3 continued



Question 3 continued

(Total for Question 3 is 8 marks)



Question 6 continued

Lined area for writing the answer to Question 6 continued.





Question 6 continued

Lined area for writing the answer to Question 6.

(Total for Question 6 is 9 marks)



6. The events A and B satisfy

$$P(A) = x \quad P(B) = y \quad P(A \cup B) = 0.65 \quad P(B|A) = 0.3$$

(a) Show that

$$14x + 20y = 13 \tag{3}$$

The events B and C are mutually exclusive such that

$$P(B \cup C) = 0.85 \quad P(C) = \frac{1}{2}x + y$$

(b) (i) Find a second equation in x and y

(ii) Hence find the value of x and the value of y (4)

(c) Determine whether or not A and B are statistically independent. You must show your working clearly.

Question 6 continued

Question 6 continued



Question 6 continued

(Total for Question 6 is 9 marks)



4. A manufacturer of pet food gives samples of three new flavours of cat food, A , B and C , to each of 100 customers who each own one cat. These customers are surveyed to find out whether or not their cat likes each flavour with the following results

40 cats like A

45 cats like B

50 cats like C

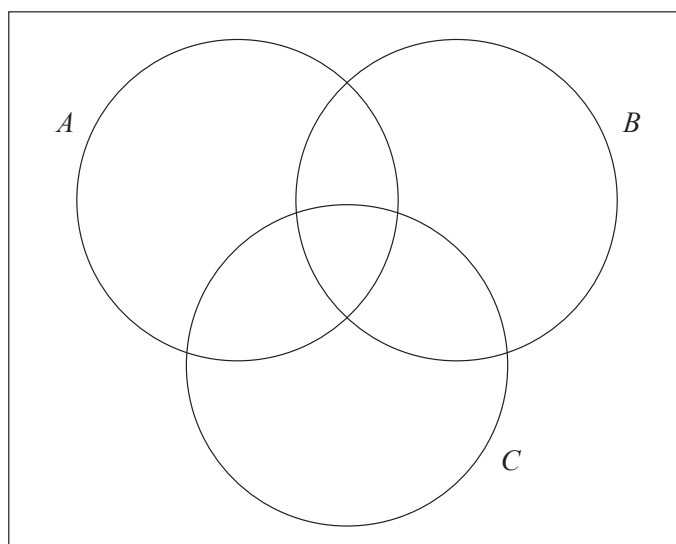
19 cats like both A and B

20 cats like both A and C

22 cats like both B and C

12 cats like all three of these flavours.

- (a) Using these results complete the Venn diagram below.



(4)

For these cats,

- (b) determine whether or not a cat liking flavour A is independent of it liking flavour C

(2)

- (c) One of these 100 cats is chosen at random.

- (i) Find the probability that it likes only one of the three flavours.

(1)

- (ii) Given that it likes flavour C , find the probability that it also likes flavour B

(2)

Question 4 continued

(Total for Question 4 is 9 marks)



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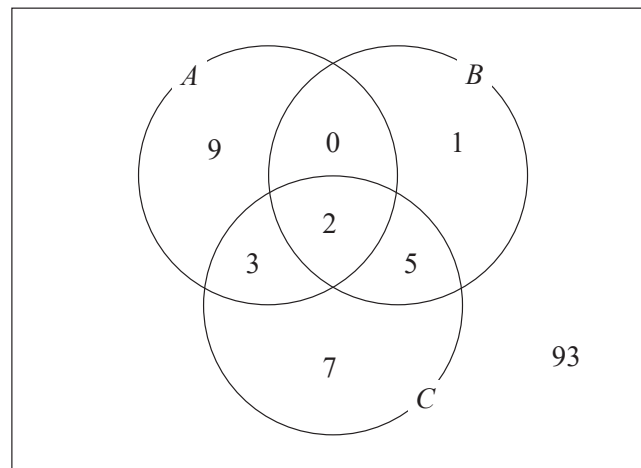
1. A factory produces shoes.

A quality control inspector at the factory checks a sample of 120 shoes for each of three types of defect. The Venn diagram represents the inspector's results.

A represents the event that a shoe has defective stitching

B represents the event that a shoe has defective colouring

C represents the event that a shoe has defective soles



One of the shoes in the sample is selected at random.

(a) Find the probability that it does **not** have defective soles.

(1)

(b) Find $P(A \cap B \cap C')$

(1)

(c) Find $P(A \cup B \cup C')$

(2)

(d) Find the probability that the shoe has at most one type of defect.

(2)

(e) Given the selected shoe has at most one type of defect, find the probability it has defective stitching.

(2)

The random variable X is the number of the events A, B, C that occur for a randomly selected shoe.

(f) Find $E(X)$

(3)

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Question 1 continued

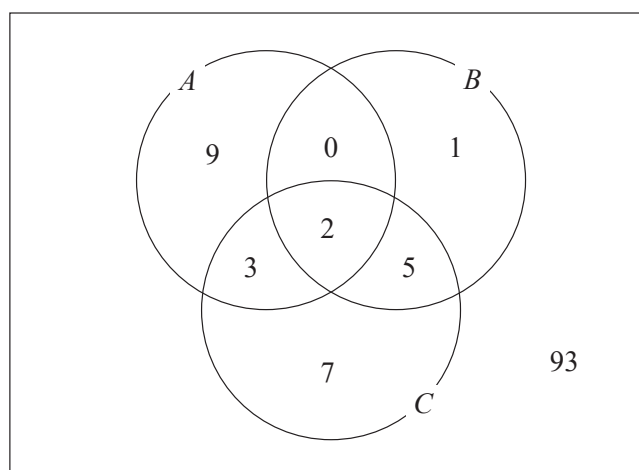
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Question 1 continued

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This is a copy of the Venn diagram for this question.



(Total 11 marks)

Q1



4. The events H and W are such that

$$P(H) = \frac{3}{8} \qquad P(H \cup W) = \frac{3}{4}$$

Given that H and W are independent,

(a) show that $P(W) = \frac{3}{5}$ (4)

The event N is such that

$$P(N) = \frac{1}{15} \qquad P(H \cap N) = P(N)$$

(b) Find $P(N'|H)$

Given that W and N are mutually exclusive,

(c) draw a Venn diagram to represent the events H , W and N giving the exact probabilities of each region in the Venn diagram.

Question 4 continued



Question 4 continued

Lined area for writing the answer to Question 4 continued.

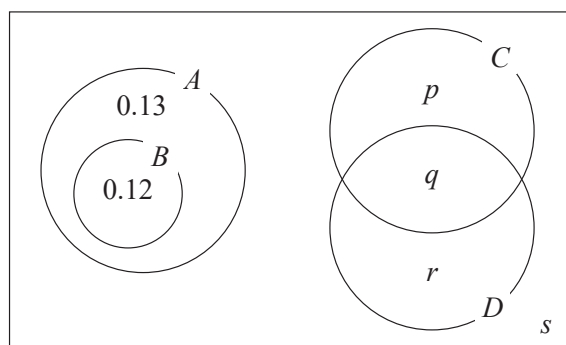


Question 4 continued

(Total for Question 4 is 11 marks)



6. The Venn diagram shows the events A , B , C and D , where p , q , r and s are probabilities.



(a) Write down the value of

- (i) $P(A)$
- (ii) $P(A|B)$
- (iii) $P(A|C)$

(3)

Given that $P(B' \cap D') = \frac{7}{10}$ and $P(C|D) = \frac{3}{5}$

(b) find the exact value of q and the exact value of r

(6)

Given also that $P(B \cup C') = \frac{5}{8}$

(c) find the exact value of s

(2)



Question 6 continued

Question 6 continued

(Total for Question 6 is 11 marks)



Question 2 continued

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Lined area for writing the answer to Question 2.

(Total 12 marks)

Q2

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3. (i) Bob shops at a market each week. The event that

Bob buys carrots is denoted by C

Bob buys onions is denoted by O

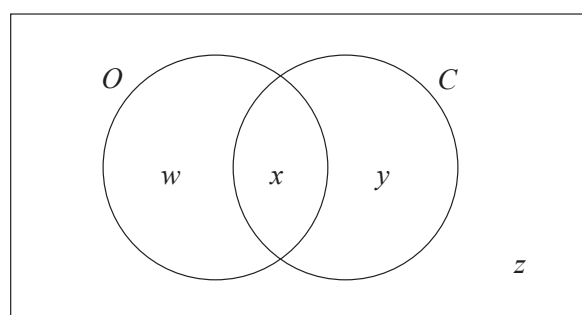
At each visit, Bob may buy neither, or one, or both of these items. The probability that

Bob buys carrots is 0.65

Bob does **not** buy onions is 0.3

Bob buys onions but not carrots is 0.15

The Venn diagram below represents the events C and O



where w , x , y and z are probabilities.

- (a) Find the value of w , the value of x , the value of y and the value of z

(4)

For one visit to the market,

- (b) find the probability that Bob buys either carrots or onions but not both.

(1)

- (c) Show that the events C and O are **not** independent.

(2)

- (ii) F , G and H are 3 events. F and H are mutually exclusive. F and G are independent.

Given that

$$P(F) = \frac{2}{7}$$

$$P(H) = \frac{1}{4}$$

$$P(F \cup G) = \frac{5}{8}$$

- (a) find $P(F \cup H)$

(1)

- (b) find $P(G)$

(3)

- (c) find $P(F \cap G)$

(1)





Question 3 continued

Question 3 continued

(Total for Question 3 is 12 marks)



Question 4 continued



Question 4 continued



Question 4 continued

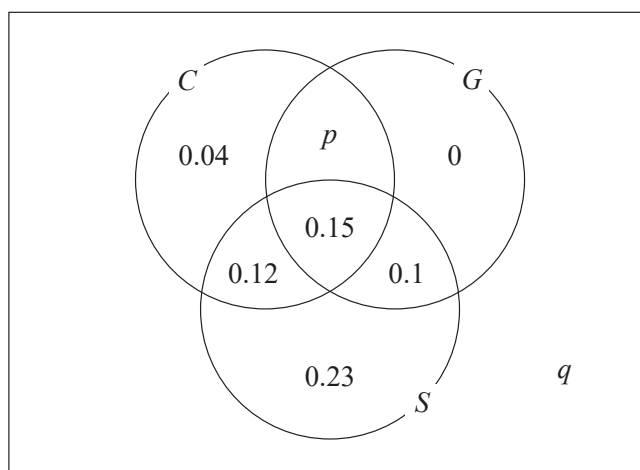
(Total for Question 4 is 13 marks)



6. The Venn diagram shows the probabilities related to teenagers playing 3 particular board games.

C is the event that a teenager plays Chess
 S is the event that a teenager plays Scrabble
 G is the event that a teenager plays Go

where p and q are probabilities.



- (a) Find the probability that a randomly selected teenager plays Chess but does not play Go.

(1)

Given that the events C and S are independent,

- (b) find the value of p

(4)

- (c) Hence find the value of q

(2)

- (d) Find (i) $P((C \cup S) \cap G')$

(1)

- (ii) $P(C \mid (S \cap G))$

(2)

A youth club consists of a large number of teenagers.
 In this youth club 76 teenagers play Chess and Go.

- (e) Use the information in the Venn diagram to estimate how many of the teenagers in the youth club do not play Scrabble.

(3)

Question 6 continued

Lined area for writing the answer to Question 6 continued.



Question 6 continued

Lined area for writing the answer to Question 6.

(Total for Question 6 is 13 marks)

TOTAL FOR PAPER IS 75 MARKS



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6. A disc of radius 1 cm is rolled onto a horizontal grid of rectangles so that the disc is equally likely to land anywhere on the grid. Each rectangle is 5 cm long and 3 cm wide. There are no gaps between the rectangles and the grid is sufficiently large so that no discs roll off the grid.

If the disc lands inside a rectangle without covering any part of the edges of the rectangle then a prize is won.

By considering the possible positions for the centre of the disc,

- (a) show that the probability of winning a prize on any particular roll is $\frac{1}{5}$ (3)

A group of 15 students each roll the disc onto the grid twenty times and record the number of times, x , that each student wins a prize. Their results are summarised as follows

$$\sum x = 61 \qquad \sum x^2 = 295$$

- (b) Find the standard deviation of the number of prizes won per student. (2)

A second group of 12 students each roll the disc onto the grid twenty times and the mean number of prizes won per student is 3.5 with a standard deviation of 2

- (c) Find the mean and standard deviation of the number of prizes won per student for the whole group of 27 students.

The 27 students also recorded the number of times that the disc covered a corner of a rectangle and estimated the probability to be 0.2216 (to 4 decimal places).

- (d) Explain how this probability could be used to find an estimate for the value of π and state the value of your estimate. (3)



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Question 6 continued

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Q6

(Total 15 marks)

TOTAL FOR PAPER IS 75 MARKS

END



SUB-TOPIC S1.2b

TREE DIAGRAMS

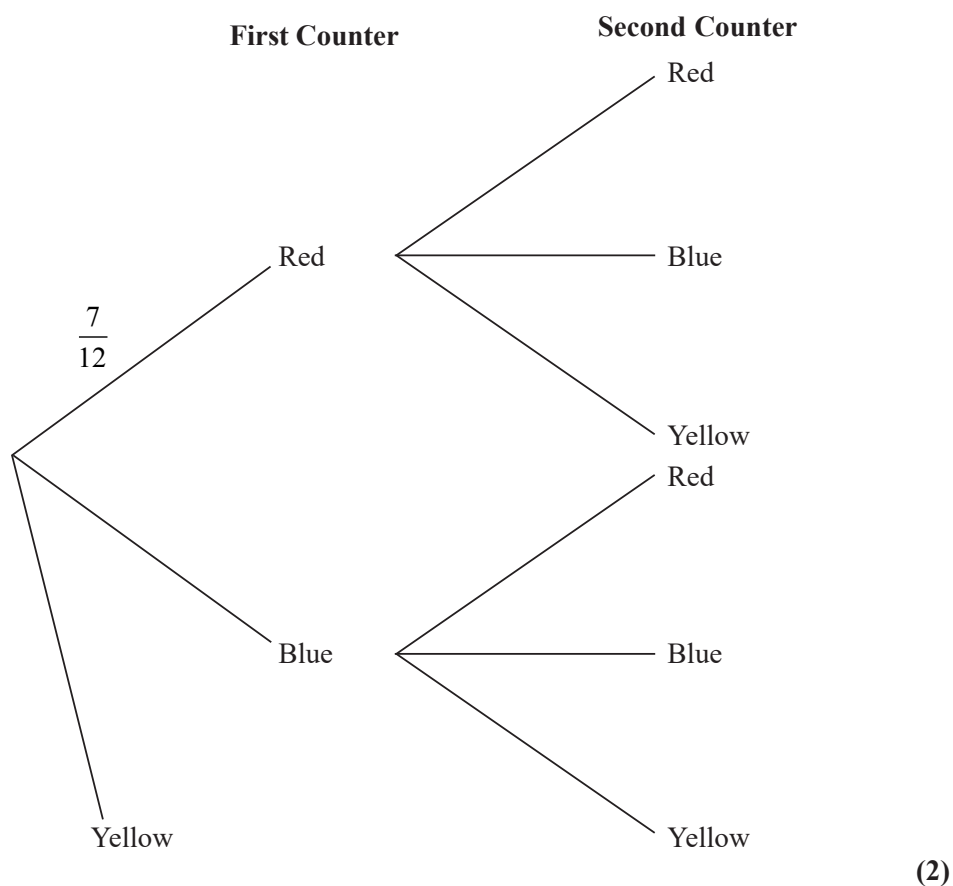
Sub-topic S1.2b · 10 questions · 97 marks · lowest tariff first



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1. There are 7 red counters, 3 blue counters and 2 yellow counters in a bag. Gina selects a counter at random from the bag and keeps it. If the counter is yellow she does not select any more counters. If the counter is not yellow she randomly selects a second counter from the bag.

(a) Complete the tree diagram.



Given that Gina has selected a yellow counter,

(b) find the probability that she has 2 counters.

(3)



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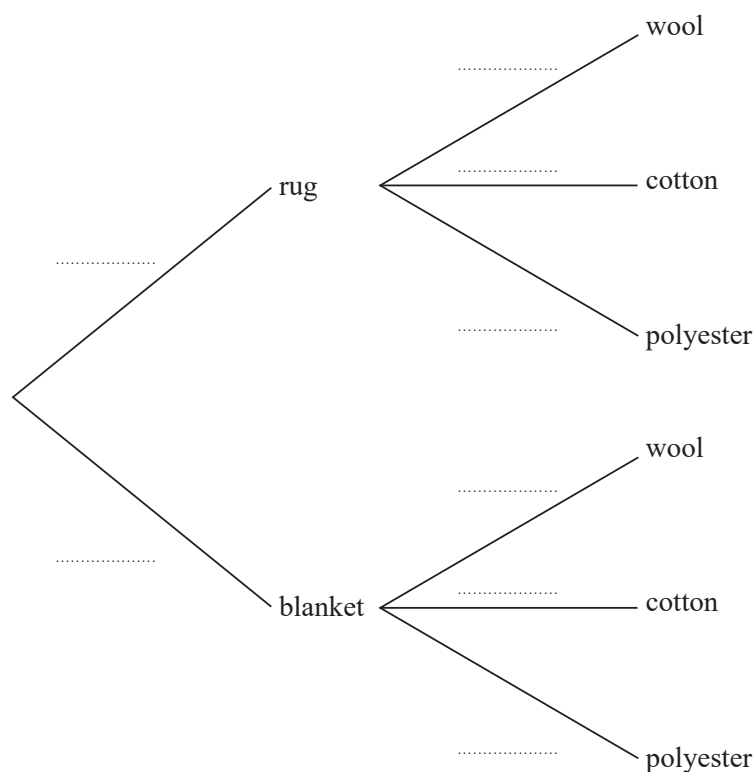
Q1

3. A factory makes rugs and blankets from wool **or** cotton **or** polyester.

- 30% of the items made are rugs and 70% of the items made are blankets
- 60% of the rugs are made from wool
- 35% of the blankets are made from wool
- 10% of the rugs are made from cotton
- 20% of the blankets are made from cotton
- the rest of the rugs and blankets are made from polyester

An item made by the factory is selected at random.

(a) Complete the tree diagram below to illustrate this information.



(2)

(b) (i) Find the probability that the item selected is **not** made from wool.

(2)

(ii) Given that this item is **not** made from wool, find the probability that it is a blanket.

(2)

Question 3 continued

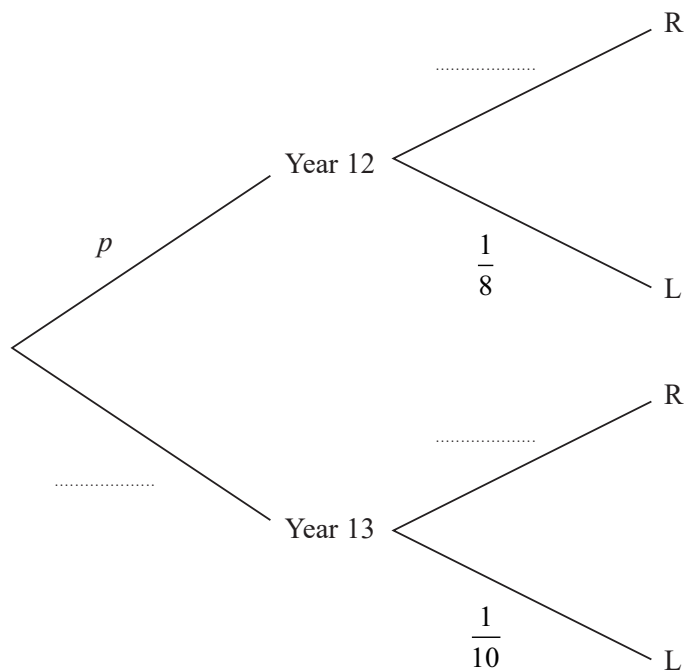
Lined area for writing the answer to Question 3.

(Total for Question 3 is 6 marks)



3. In a sixth form college each student in Year 12 and Year 13 is either left-handed (L) or right-handed (R).

The partially completed tree diagram, where p is a probability, gives information about these students.



- (a) Complete the tree diagram, in terms of p where necessary.

(1)

The probability that a student is left-handed is 0.11

- (b) Find the value of p

(3)

- (c) Find the probability that a student selected at random is in Year 12 and left-handed.

(2)

Given that a student is right-handed,

- (d) find the probability that the student is in Year 12

(2)

Question 3 continued

Lined area for writing the answer to Question 3.

(Total for Question 3 is 8 marks)



4. A bag contains a large number of coloured counters. Each counter is labelled A, B or C

30% of the counters are labelled A

45% of the counters are labelled B

The rest of the counters are labelled C

It is known that

2% of the counters labelled A are red

4% of the counters labelled B are red

6% of the counters labelled C are red

One counter is selected at random from the bag.

- (a) Complete the tree diagram on the opposite page to illustrate this information.

(2)

- (b) Calculate the probability that the counter is labelled A and is not red.

(2)

- (c) Calculate the probability that the counter is red.

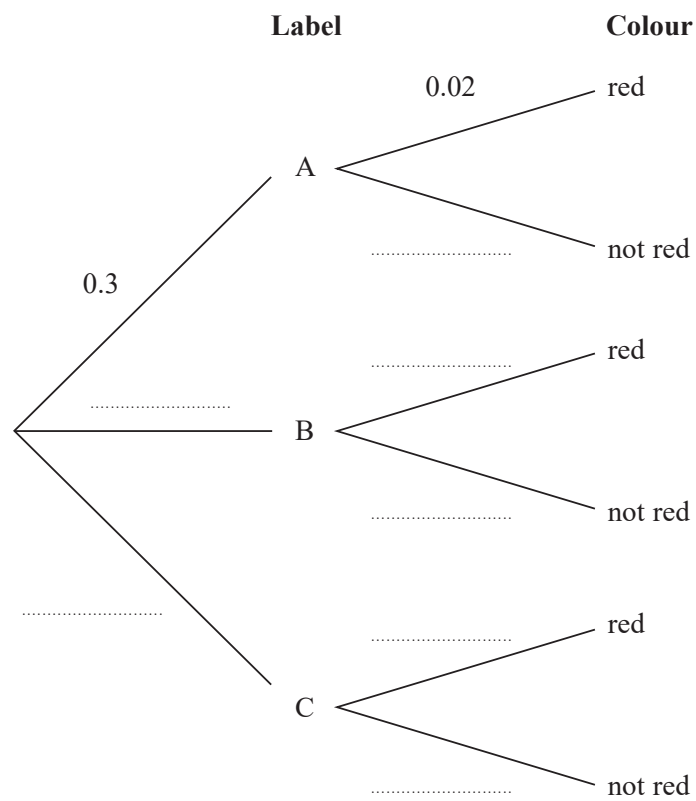
(2)

- (d) Given that the counter is red, find the probability that it is labelled C

(3)



Question 4 continued



(Total for Question 4 is 9 marks)

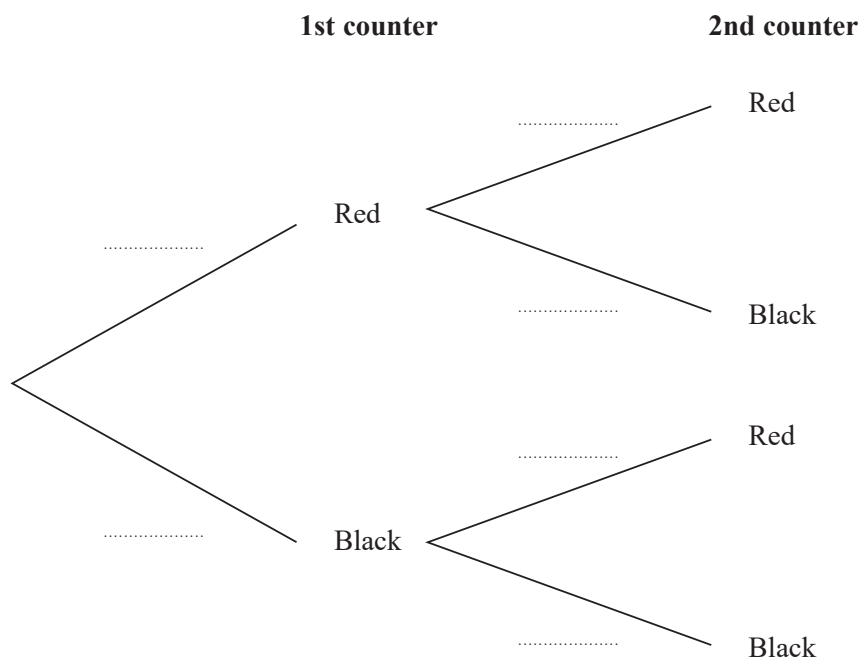


7. A box contains only red counters and black counters.

There are n red counters and $n + 1$ black counters.

Two counters are selected at random, one at a time **without** replacement, from the box.

- (a) Complete the tree diagram for this information. Give your probabilities in terms of n where necessary.



(3)

- (b) Show that the probability that the two counters selected are different colours is

$$\frac{n+1}{2n+1}$$

(2)

The probability that the two counters selected are different colours is $\frac{25}{49}$

- (c) Find the total number of counters in the box before any counters were selected.

(2)

Given that the two counters selected are different colours,

- (d) find the probability that the 1st counter is black.
You must show your working.

(2)

Question 7 continued

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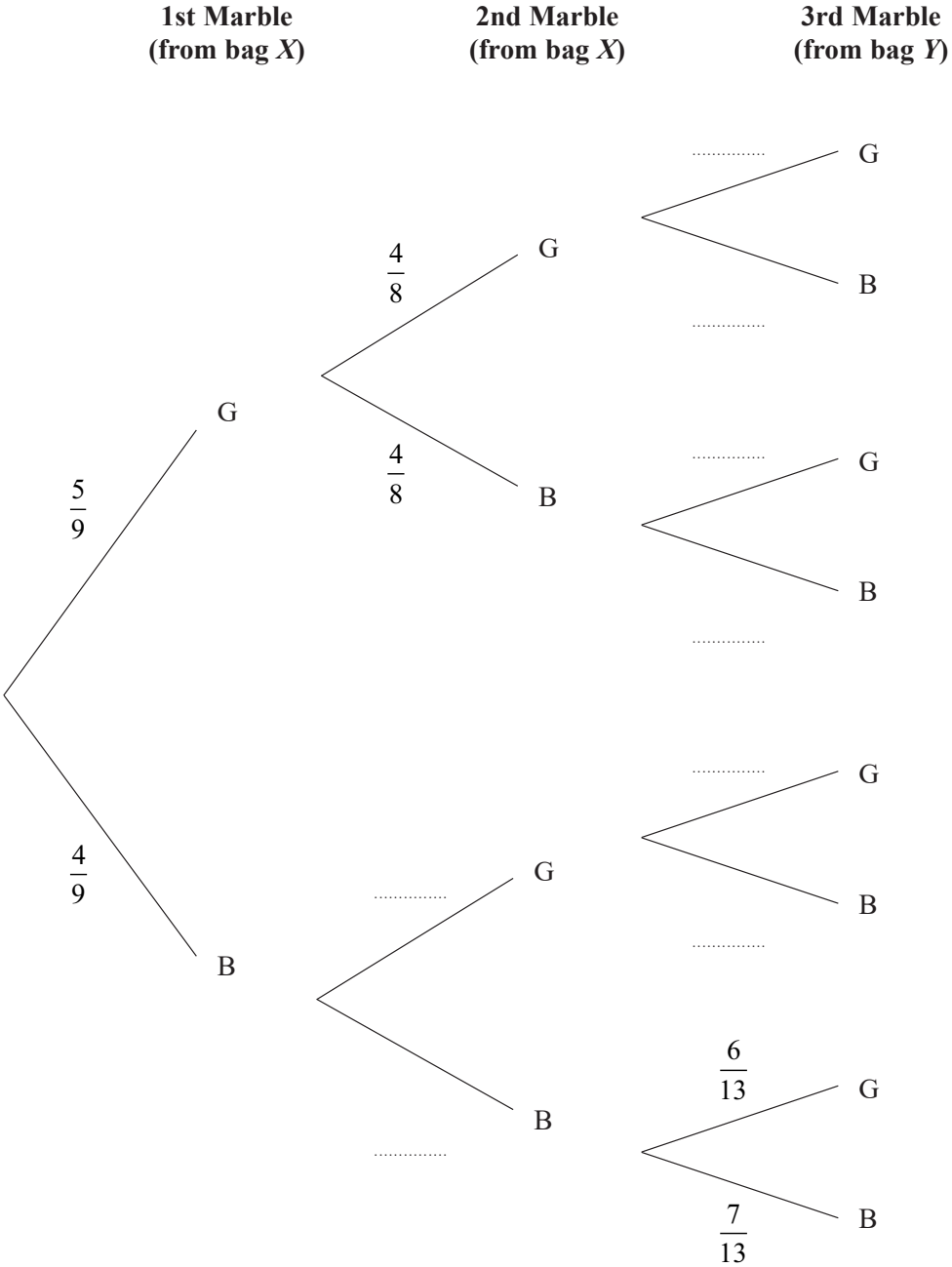




(Total for Question 7 is 2 marks)



Question 2 continued





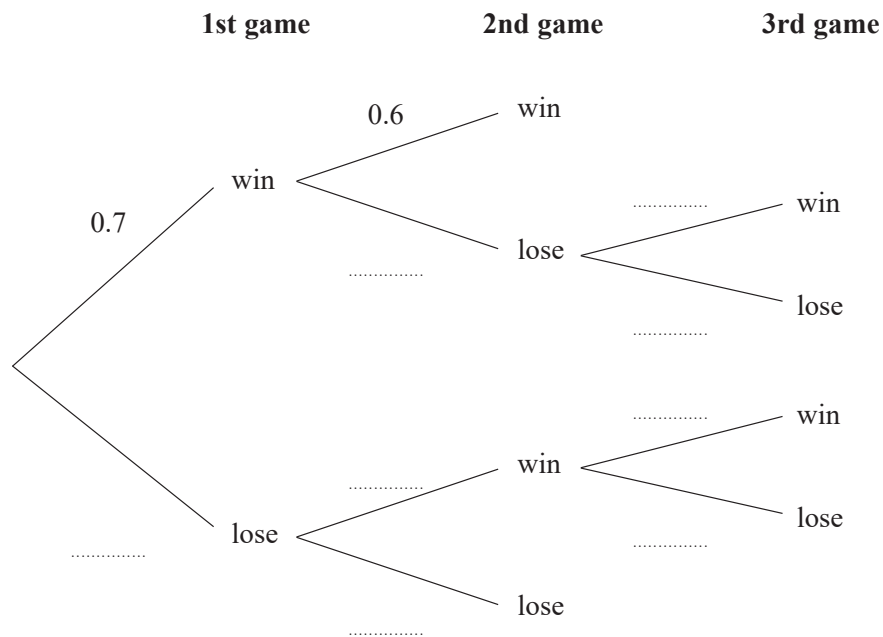
Question 2 continued

Lined area for writing the answer to Question 2.

(Total for Question 2 is 10 marks)



Question 1 continued





Question 1 continued

Lined area for writing the answer to Question 1.

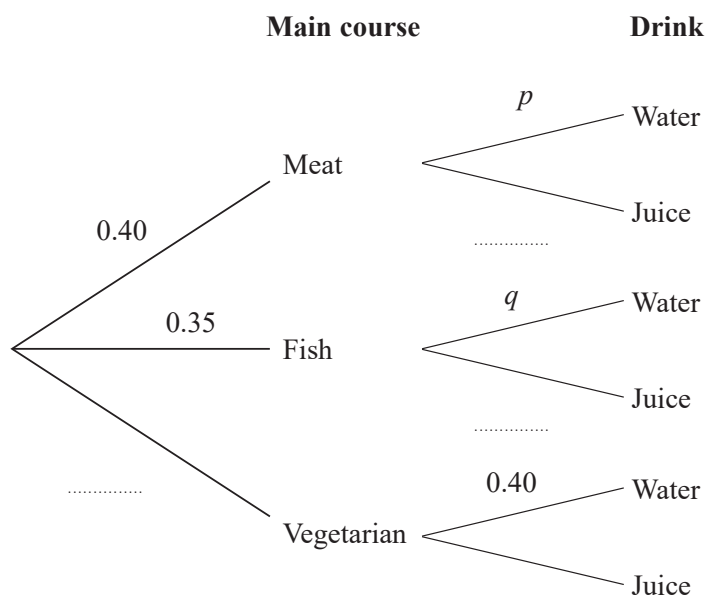
(Total for Question 1 is 11 marks)



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2. In a school canteen, students can choose from a main course of meat (M), fish (F) or vegetarian (V). They can then choose a drink of either water (W) or juice (J).

The partially completed tree diagram, where p and q are probabilities, shows the probabilities of these choices for a randomly selected student.



- (a) Complete the tree diagram, giving your answers in terms of p and q where appropriate. (2)

- (b) Find an expression, in terms of p and q , for the probability that a randomly selected student chooses water to drink. (1)

The events “choosing a vegetarian main course” and “choosing water to drink” are independent.

- (c) Find a linear equation in terms of p and q . (2)

A student who has chosen juice to drink is selected at random. The probability that they chose fish for their main course is $\frac{7}{30}$

- (d) Find the value of p and the value of q . (5)

The canteen manager claims that students who choose water to drink are most likely to choose a fish main course.

- (e) State, showing your working clearly, whether or not the manager’s claim is correct. (3)

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Question 2 continued

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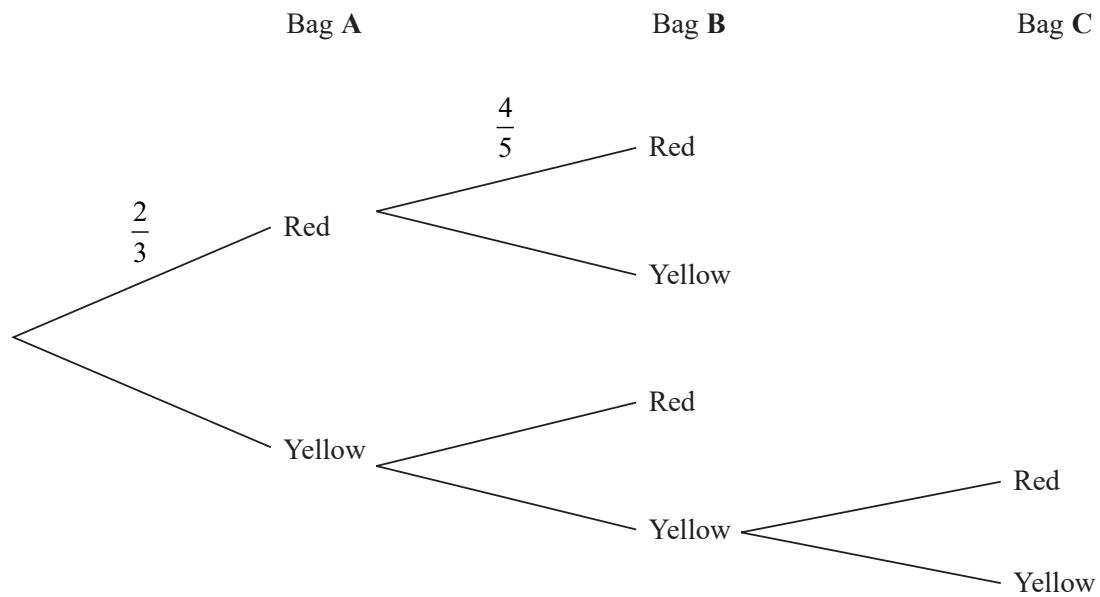
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Q2

Grading boxes for Question 2.



Question 4 continued

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Question 4 continued

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Lined area for writing the answer to Question 4 continued.



Question 4 continued

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Lined area for writing the answer to Question 4.

(Total 13 marks)

Q4



7. Riley has a bag containing 3 white beads and 6 yellow beads only.

Two beads are selected at random from the bag, one at a time without replacement.

- (a) Complete the tree diagram on page 21

(3)

- (b) Find the probability that exactly one of the beads selected is yellow. Show your working.

(2)

- (c) Find the probability that at least one of the beads selected is white.

(2)

Given that at least one of the beads selected is white,

- (d) find the probability that both of the beads selected are white.

(2)

Riley adds some beads to the bag so it contains a total of n beads. The beads are either red or yellow or white such that

number of **red** beads : number of **yellow** beads : number of **white** beads = 4 : 3 : 1

Four beads are selected at random from the bag, one at a time without replacement.

The probability of getting 2 red beads, followed by a yellow bead, followed by a

white bead is $\frac{3}{235}$

- (e) Show that n satisfies the equation

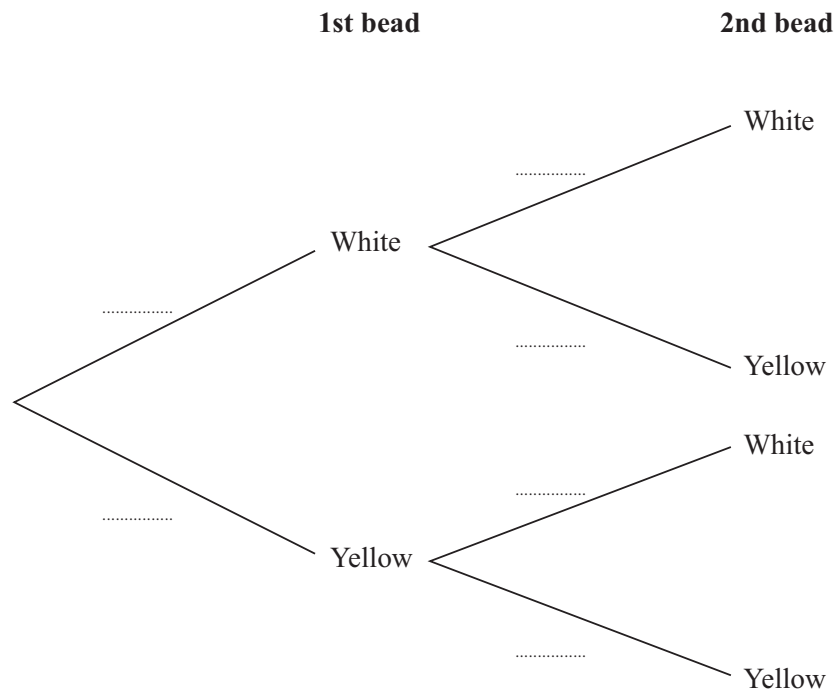
$$21n^2 + bn + c = 0$$

where b and c are integers to be found.

(4)



Question 7 continued



Question 7 continued

Lined area for writing the answer to Question 7 continued.



Question 7 continued

Lined area for writing the answer to Question 7.



Question 7 continued

Lined area for writing the answer to Question 7.

(Total for Question 7 is 13 marks)

TOTAL FOR PAPER IS 75 MARKS



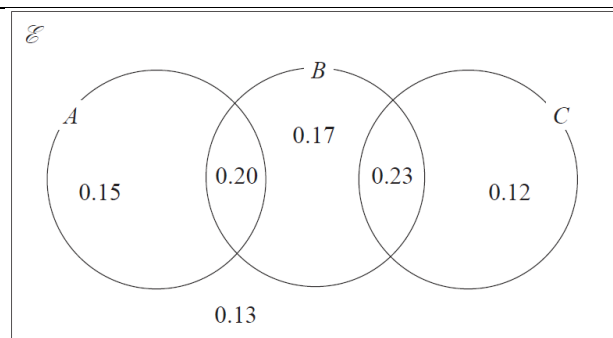
MARK SCHEMES

official mark schemes, in the same order as the questions

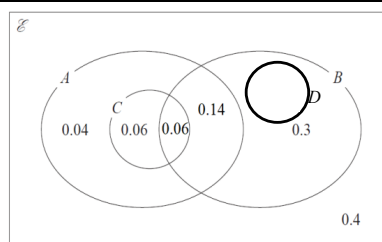
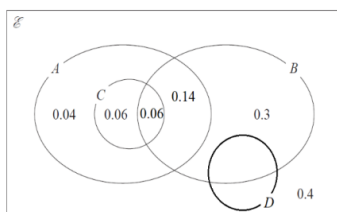


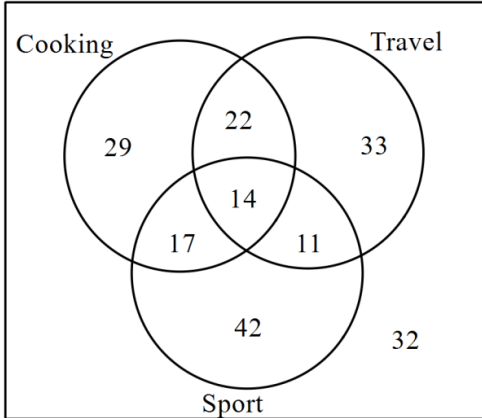
Question	Scheme	
4 (a)	$0.2 = \frac{P(C \cap D)}{0.45}$	M1
	$[P(C \cap D) =] 0.09$	A1
		(2)
(b)	$0.59 = P(C) + 0.45 - "0.09" \quad [\rightarrow P(C) = 0.59 - 0.45 + "0.09"]$	M1
	$= 0.23$	A1
		(2)
Notes		Total 4
Mark (a) and (b) together		
(a)	M1 for substitution of 0.2 and 0.45 into a correct equation for $P(C \cap D)$ (allow any rearrangement)	
	A1 oe correct answer scores 2 out of 2 Must be clearly identified as the answer to part (a). A correct Venn diagram on its own is not sufficient.	
(b)	M1 for correct substitution of 0.59, 0.45 and "their a" into $P(C \cup D) = P(C) + P(D) - P(C \cap D)$ Implied by "their (b)" – "their(a)" = 0.14 $0.59 = P(C) + 0.45$ is M0 Only ft $0 < \text{"their (a)} < 1$ If "their (a)" is outside this range, then M0	
	A1 oe correct answer scores 2 out of 2	

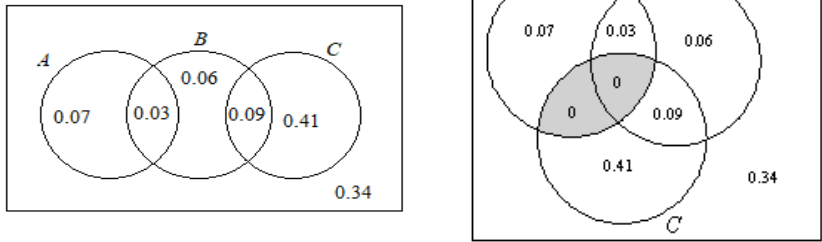
Question Number	Scheme	Marks
1 (a)	$[0.15 + 0.13 + 0.12 =]$ <u>0.4</u>	B1 (1)
(b)	$0.15 + 0.20 + 0.23 + 0.12$ <u>or</u> $1 - (0.17 + 0.13)$ <u>or</u> $0.35 + 0.35$ $=$ <u>0.7</u>	M1 A1 (2)
(c)	$[P(A B') =] \frac{P(A \cap B')}{P(B')}$ and $\frac{p}{\text{"0.4"}}$ <u>or</u> $\frac{0.15}{\text{"0.4"}}$ $= \frac{3}{8}$	M1 A1 (2)
Notes		
(a)	B1 for 0.4 or exact equivalent	
(b)	M1 for a correct sum or expression A1 for 0.7 or an exact equivalent. Correct answer with no incorrect working 2/2	
(c)	M1 for $\frac{P(A \cap B')}{P(B')}$ and $\frac{p}{\text{"0.4"}}$ where $0 < p < \text{"0.4"}$ <u>or</u> just $\frac{0.15}{\text{"0.4"}}$ Condone one missing "P" e.g. $\frac{P(A \cap B')}{(B')}$ but NOT $P\left(\frac{A \cap B'}{B'}\right)$ or $\frac{A \cap B'}{B'}$ but of course they may score this M mark from $\frac{0.15}{\text{"0.4"}}$ A1 for $\frac{3}{8}$ or exact equivalent e.g. 0.375 but $\frac{0.15}{0.4}$ is A0 Correct answer with no incorrect working 2/2	



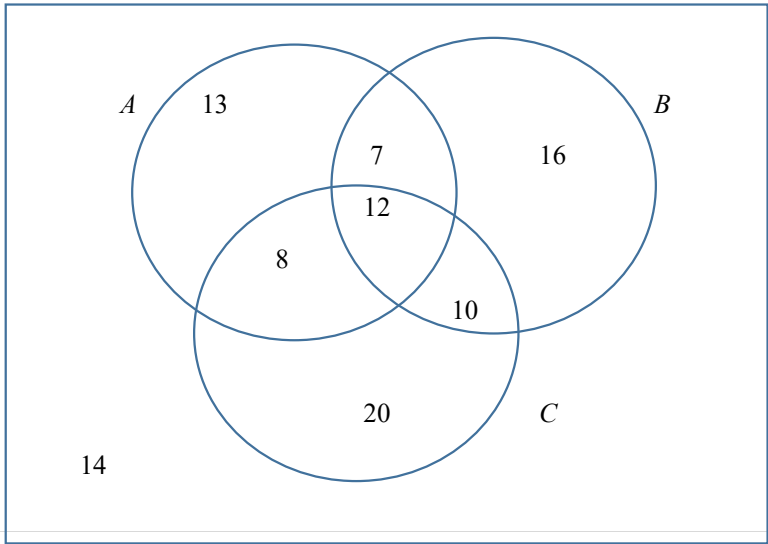
Question Number	Scheme	Marks
1 (a)	[Sum of probs = 1 gives $p + q = 0.2$ and] so $P(B) = \underline{0.5}$	B1 (1)
(b)	e.g. $P(A) = 0.3$ or $0.1 +$ "their value for $p + q$ ", $P(A \cap B) = 0.2$ or "their value for $p + q$ ", and $[P(A) \times P(B) =] 0.3 \times "0.5" [= "0.15"]$ $0.15 \neq 0.2$ so $[A \text{ and } B \text{ are}]$ not independent	M1 A1 (2)
(c)	$[P(C B) =] \frac{p}{"0.5"} = p + 0.06$ (o.e.) $[2p = p + 0.06 \text{ so }] \underline{p = 0.06}$ [Use of $p + q = 0.2$ gives] $\underline{q = 0.14}$	M1 A1 A1 (3)
(d)	Suitable event D drawn. [See Venn diagrams below]	B1 (1)
Notes		
(a)	B1 for 0.5 or exact equivalent	
(b)	M1 for sight of correct probabilities for $P(A)$ and $P(A \cap B)$ clearly labelled , $0.3 \times "0.5"$ seen or $P(A) \times P(B) = 0.15$ Allow $0.04 + 0.06 + 0.2$ for $P(A)$ if clearly labelled $P(A \cap B)$ may be stated in part (a) $P(B)$ can fit from (a) eg $P(A) = "0.5" - 0.3 - 0.2$ May see $P(B A) = \frac{2}{3}$ and compared with $P(B)$ or $P(A B) = 0.4$ and $P(A) = 0.3$	
ALT	A1 For all the correct probabilities and calculations, a comparison and correct conclusion. We need to see 0.15 but will accept $P(A \cap B) \neq P(A) \times P(B)$ instead of $0.15 \neq 0.2$ for comparison SC Allow M1A0 for $P(A) = 0.1 + p + q$; $P(A \cap B) = p + q$ clearly labelled and $0.5 \times (0.1 + p + q)$ or $(p + q + 0.3)(0.1 + p + q)$ given.	
(c)	M1 fit their $P(B)$ from part (a). For a correct equation in p or q based on the given statement. NB equation in terms of q is $\frac{0.2 - q}{"0.5"} = 0.26 - q$ (o.e.) Allow $\frac{p}{0.3 + p + q} = p + 0.06$ 1 st A1 for $(p =) 0.06$ 2 nd A1 for $(q =) 0.14$ $(p =) 0.06$ and $(q =) 0.14$ 3/3	
Ans only		
(d)	B1 for a suitable event D drawn that has an intersection with B but not with A . Condone if not labelled D	



Question Number	Scheme		Marks
3 (a)			B1 B1 B1
			(3)
(b) (i)	$\frac{14}{200}$		B1ft (1)
(ii)	$\frac{33+11+42+32}{200} = \frac{118}{200}$ or $\frac{200-29-22-14-17}{200} = \frac{118}{200}$		M1 A1
			(2)
(c)	$\frac{14+11}{14+11+22+33} = \frac{25}{80}$		M1 A1
			(2)
Notes			Total 8
(a)	B3	For a fully correct Venn diagram (B2 for at least 6 numbers in the correct place on the Venn diagram) (B1 for at least 3 numbers in the correct place on the Venn diagram) Treat blanks on the diagram as zero Condone correct probabilities instead of frequencies e.g. $\frac{22}{200}$ oe or 0.11 as 22	
(b) (i)	B1ft	For $\frac{14}{200}$ oe ft their Venn diagram	
(ii)	M1	$\frac{33+11+42+32}{200}$ or $\frac{200-29-22-14-17}{200}$ ft their Venn diagram. May be implied by $\frac{118}{200}$ oe	
	A1	For $\frac{118}{200}$ oe	
(c)	M1	$\frac{n}{14+11+22+33}$ provided the answer gives a probability and $0 < n < 80$ ft the Venn diagram for the denominator or $\frac{m}{0.4}$ where $0 < m < 0.4$ ft the Venn diagram for the denominator	$\frac{n}{80}$ provided $0 < n < 80$ ft the Venn diagram for numerator or $\frac{m}{0.4}$ where $0 < m < 0.4$ ft the Venn diagram for numerator
	A1	For $\frac{25}{80}$ oe Allow 0.313	

Qu	Scheme	Marks
6(a)	0.6	B1
		(1)
(b)	$[P(A \cap B) =] 0.1 \times 0.3$ or $0.3 = \frac{P(A \cap B)}{0.1}$	M1
	$0.25 = 0.1 + P(B) - "0.03"$ or $0.25 = 0.1 + P(B) - P(A \cap B)$	M1
	$0.25 = 0.1 + P(B) - 0.03$ or $0.3 = \frac{P(B) - 0.15}{0.1} \therefore P(B) = 0.18^*$	A1*
		(3)
(c)		M1 M1 B1ft B1ft A1
		(5)
	Notes	Total 9
(a)	B1cao	
(b)	M1 for use of $P(B A) = \frac{P(A \cap B)}{P(A)}$ with 0.1 and 0.3 substituted. Allow for 0.1×0.3 seen	
	M1 $0.25 = 0.1 + P(B) - p$ where $0 < p < 1$ or $p = P(A \cap B)$ oe eg $0.25 - 0.1 + p = P(B)$ (allow any letter for $P(B)$)	
	A1* $P(B) = 0.18$ depends on both previous M marks for a fully correct equation in terms of $P(B)$ (allow any letter for $P(B)$) followed by $P(B) = 0.18$	
	NB 0.03 used/stated with no working could get M0M1A0 Using $P(A \cap B) = 0.1 \times P(B)$ then they get M0M0A0 Verification could get M1M1A0 M1 for 0.1×0.3 M1 for $0.25 - 0.18 - 0.1 = -0.03$ or $0.3 = \frac{0.18 - 0.15}{0.1}$ or $0.25 = 0.1 + 0.18 - P(A \cap B)$	
(c)	M1 for 3 circles as per either diagram. If using Diagram 2 we must see exactly 2 zeros in one of the intersections (as shaded). (Do Not accept blank or dash instead of 0) Condone missing rectangle. Ignore labels	
	M1 for 0.09 and 0.41 marked correctly in diagram – condone incorrect/no label but must be in the left or right hand circles in 1 st diagram or must have zeros (condone blank or dash) in the 2 other regions of the circle if in 2 nd diagram	
	B1ft their "0.03" in correct place on diagram. Correct label required	
	B1ft for 0.34 or ft 0.75 – "their 0.41" where their $0.41 \neq 0.5$ No other ft accepted. Do not allow 0.75	
	A1 fully correct Venn diagram including the rectangle and all 3 labels.	
	SC no labels could get M1M1B0B1A0 if using 3 intersecting circles must have blanks or 0 for the 2 nd M1	

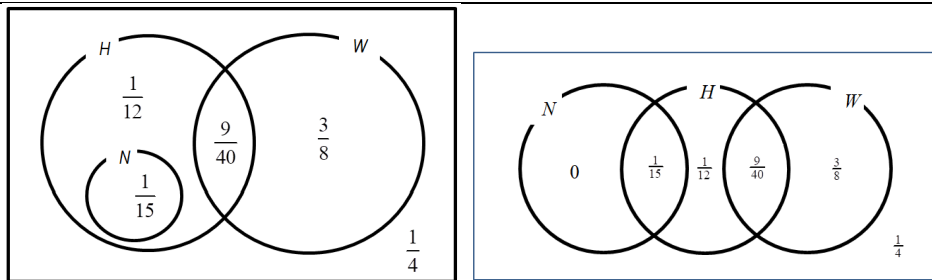
Question Number	Scheme		Marks
6 (a)	$P(B A) = \frac{P(B \cap A)}{P(A)}$		
	$0.3 = \frac{P(B \cap A)}{x} \Rightarrow P(B \cap A) = 0.3x$		M1
	$P(A \cup B) = P(A) + P(B) - 'P(A \cap B)'$		M1
	$0.65 = x + y - 0.3x \Rightarrow 0.65 = 0.7x + y$		
	$14x + 20y = 13^*$		A1*
			(3)
(b)(i)	$P(B \cup C) = P(B) + P(C)$ or $P(B \cap C) = 0$		M1
	$0.85 = \frac{1}{2}x + 2y$		A1
(ii)	Attempt to solve the 2 equations simultaneously		M1
	$x = 0.5$ $y = 0.3$		A1
			(4)
(c)	$P(B A) = 0.3$ and $P(B) = '0.3'$	$P(A) \times P(B) = '0.5' \times '0.3'$ and $P(A \cap B) = 0.3 \times '0.5'$ or $P(A \cap B) = '0.5' + '0.3' - 0.65$	M1
	So, A and B are statistically independent		A1ft
			(2)
Notes			Total 9
(a)	M1	Use of $P(B A) = \frac{P(B \cap A)}{P(A)}$ assuming independence is M0 e.g. $P(B \cap A) = P(B) \times P(A) [= xy]$ May be implied by $P(B \cap A) = 0.3x$ (may be seen on a Venn diagram)	
	M1	Use of $P(A \cup B) = P(A) + P(B) - P(A \cap B)$ with substitution of $P(A \cup B)$, $P(A)$ and $P(B)$ (the equation may be seen in a Venn diagram) $0.65 = x + y - 0.3x$ implies M1M1	
	A1*	Answer is given so no incorrect working can be seen	
(b)(i)	M1	Use of $P(B \cup C) = P(B) + P(C)$ or sight of $P(B \cap C) = 0$	
	A1	Any correct second equation in x and y which need not be simplified.	
(ii)	M1	Attempt to solve the 2 equations simultaneously. Either a correct substitution seen or a correct method to eliminate x or y	
	A1	For $x = 0.5$ and $y = 0.3$	
(c)	M1	For finding all of the probabilities needed for a test for independence (probabilities must be labelled) ft their values of x and y $P(B A)$ and $P(B)$ or $P(A)$, $P(B)$ and $P(A \cap B)$ For $P(A \cap B)$ we must see working shown	
	A1ft	For a correct ft conclusion for their values of x and y (must have scored M1)	

Question Number	Scheme		Marks
4(a)			B1 B1 B1ft B1
			(4)
(b)	$P(A) = \frac{40}{100}$ $P(C) = \frac{50}{100}$ $P(A \cap C) = \frac{20}{100}$ $P(A) \times P(C) = P(A \cap C)$ therefore (A and C are) independent	$P(A) = \frac{40}{100}$ $P(A C) = \frac{20}{50}$ $P(A) = P(A C)$ therefore (A and C are) independent	M1 A1 (2)
(c)(i)	$\left[\frac{'13' + '16' + '20'}{100} \right] = \frac{49}{100}$		B1ft (1)
(ii)	$P(\text{likes } B \text{likes } C) = \frac{'12' + '10'}{'12' + '10' + '8' + '20'}$ $= \frac{22}{50}$		M1 A1 (2)
Notes			Total 9
(a)		In part (a) allow the numbers in the Venn diagram written as probabilities eg 0.12, 0.07, 0.08 etc.	
	B1	12 correct in the centre of the Venn diagram	
	B1	At least two of 7, 8 and 10 correct	
	B1ft	Any one of 13, 16 or 20 correct ft their 7,8,10 and 12 (must be positive) such that the 4 regions of A = 40 or the 4 regions of B = 45 or the 4 regions of C = 50 Do not accept blank regions as 0 for ft.	
	B1	All correct including the 14	
(b)	M1	Labelling all of the probabilities needed for a test of independence (probabilities must be correct or correct ft from their Venn diagram). Must use A and C Either P(A), P(C) and P(A ∩ C) or eg P(A) and P(A C)	
	A1	Stating correct test with correct values P(A) × P(C) = P(A ∩ C) or eg P(A) = P(A C) and correct conclusion of independence	
(c)(i)	B1ft	Ft their “13”, “16” and “20” provided the answer is a probability	
(ii)	M1	Correct method for conditional probability using all appropriate regions of their Venn Diagram Condone $\frac{n}{50}$ (provided it does not come from simplification of $\frac{2n}{100}$) or $\frac{\frac{n}{100}}{\frac{50}{100}}$ with n = 34 $\frac{22}{100}$ scores M1 Assuming independence is M0 eg $\frac{45}{100} \times \frac{50}{100}$	
	A1	0.44 oe	

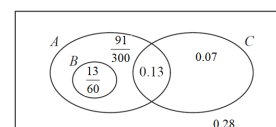


1. (a)	$P(C') = \frac{103}{120}$ oe	awrt 0.858	B1 (1)
(b)	$P(A \cap B \cap C') = 0$		B1 (1)
(c)	$P(A \cup B \cup C') = \frac{9+3+2+5+1+93}{120}$ or $P(A \cup B \cup C') = 1 - \frac{7}{120}$ $= \frac{113}{120}$ oe	awrt 0.942	M1 A1 (2)
(d)	$P(\text{At most 1}) = P(0 \text{ or } 1) = \frac{93+9+7+1}{120}$ or $\frac{120-2-5-3}{120}$ $= \frac{110}{120}$ oe	awrt 0.917	M1 A1 (2)
(e)	$P(A \text{At most 1}) = \frac{9/120}{110/120}$ $= \frac{9}{110}$ oe	awrt 0.0818	M1 A1 (2)
(f)	$\left[P(X=0) = \frac{93}{120} \right] P(X=1) = \frac{17}{120} P(X=2) = \frac{8}{120} P(X=3) = \frac{2}{120}$ $E(X) = \left[\frac{93}{120} \times 0 \right] + \frac{17}{120} \times 1 + \frac{8}{120} \times 2 + \frac{2}{120} \times 3$ $= \frac{13}{40}$ or 0.325 oe		M1 M1 A1 (3)
Notes			[11]
(a)	B1 (allow awrt 0.858)		
(b)	B1 cao condone 0/120 but do not allow other denominators		
(c)	M1 for either correct expression for $P(A \cup B \cup C')$ A1 o.e. (allow awrt 0.942)		
(d)	M1 correct expression A1 $\frac{11}{12}$ o.e. (allow awrt 0.917)		
(e)	M1 follow through their part (d) if num < denom eg $\frac{m/120}{110/120}$ or if the fraction in (d) has denominator of 120 $\frac{m}{120}$ where $0 < m < 110$ Allow $\frac{n}{120-3-2-5}$ or $\frac{n}{110}$ where $0 < n < 110$ A1 o.e. (allow awrt 0.0818)		
(f)	1 st M1 for the probability distribution of X (condone missing $P(X=0)$) awrt 0.14 awrt 0.067 and awrt 0.017 May be implied by a correct expression for $E(X)$. At least 2 correct must be associated with the correct x value 2 nd M1 correct follow through expression for $E(X)$ ft their probabilities and X values A1 Dep on both previous method marks being awarded. Working must be checked. A correct answer with no working scores 3/3 SC $P(X=17) = 17/120$ (awrt 0.14) $P(X=8) = 8/120$ (awrt 0.067) $P(X=14) = 14/120$ (awrt 0.12) leading to awrt 4.58 or $183/40$ gains M0M1A0		

Question Number	Scheme	Marks
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	A1	awrt 144	
Question Number	Scheme		Marks
4(a)	$P(H \cup W) = P(H) + P(W) - P(H \cap W)$	$P(H' \cap W) = P(H \cup W) - P(H)$	M1
	$P(H \cap W) = \frac{3}{8} \times P(W)$	$P(H' \cap W) = P(H') \times P(W)$	M1
	$\frac{3}{4} = \frac{3}{8} + P(W) - \frac{3}{8} P(W)$	$\frac{3}{8} = \frac{5}{8} P(W)$	A1
	$P(W) = \frac{3}{5}^*$	$P(W) = \frac{3}{5}^*$	A1cso*
			(4)
(b)	$P(N' H) = \frac{\frac{3}{8} - \frac{1}{15}}{\frac{3}{8}} \text{ or } \frac{\frac{9}{40} + \frac{1}{12}}{\frac{3}{8}} \text{ or } 1 - \frac{1}{15}$		M1
	$= \frac{37}{45} = \text{awrt } 0.822$		A1
			(2)
(c)			B1 M1 M1 M1 A1 (5)
	Notes		Total 11
(a)	M1	for use of $P(H \cup W) = P(H) + P(W) - P(H \cap W)$ (with at least one value correctly substituted) or use of $P(H' \cap W) = P(H \cup W) - P(H)$ (with at least one value correctly substituted)	
	M1	for use of $P(H \cap W) = P(H) \times P(W)$ or use of $P(H' \cap W) = P(H') \times P(W)$	
	A1	a correct equation in $P(W)$ (allow W or x here)	
	A1cso*	Correct solution ending with $P(W) = \frac{3}{5}$ with no wrong working seen. Dep. on all previous marks.	
	NB	A method which uses $\frac{3}{5}$ or $\frac{3}{5} \times \frac{3}{8} = \frac{9}{40}$ can score maximum M1M1A0A0.	
(b)	M1	For $\frac{p}{\frac{3}{8}}$ where $0 < p < \frac{3}{8}$ use of independence is M0 e.g. $\frac{x \times \frac{3}{8}}{\frac{3}{8}}$	
	A1	awrt 0.822	
(c)	B1	3 circles labelled. Either N inside H or allow as intersecting circles with $P(N \cap H') = 0$, but do not allow blank space to be considered 0. Condone missing box for this mark. Allow all 3 circles overlapping with all zeros correctly labelled.	
	M1	For $P(H \cap W) = \frac{3}{8} \times \frac{3}{5} = \frac{9}{40}$ seen or correctly placed in Venn diagram.	
	M1	For their $\frac{3}{5} - \frac{9}{40} = \frac{3}{8}$ (may be implied by the regions in their $P(W)$ adding to 0.6)	
	M1	For their $\frac{3}{8} - \frac{9}{40} - \frac{1}{15} = \frac{1}{12}$	
	A1	Fully correct diagram with $\frac{1}{4}$ and box and correct probabilities (allow exact decimal equivalents)	

Question Number	Scheme	Marks
2. (a)	B and C	B1 (1)
(b)	A and C independent gives: $P(C) \times 0.65 = 0.13$ or $0.65 \times (r + 0.13) = 0.13$ or $0.65 \times (0.48 - s) = 0.13$ $P(C) = 0.2$ or $r + 0.13 = 0.2$ or $0.48 - s = 0.2$ $r \{= 0.2 - 0.13\} = \underline{0.07}$ or $s \{= 0.48 - 0.2\} = \underline{0.28}$ $P(A) + r + s = 1$ or $0.65 + "0.07" + s = 1$ or $0.65 + "0.28" + r = 1$ $s \{= 1 - 0.72\} = \underline{0.28}$ and $r \{= 1 - 0.93\} = \underline{0.07}$	M1 A1 A1 M1 A1 (5)
(c)	$P[(B \cup C)] = "0.2" + q$ or $0.13 + "0.07" + q$ $P(A \cap C') = p + q \{= 0.52\}$ $\{P[(A \cap C') \cap (B \cup C)] = q \Rightarrow\} \quad "(p + q) \times "(0.2 + q)" = q$ or $"(p + q) \times "(0.13 + "0.07" + q)" = q$ or $"(p + q) \times "(1 - s - p)" = 0.52 - p$ [Using $p + q = 0.52$] $0.52 \times "(0.2 + q)" = q$ or $0.52(0.72 - p) = 0.52 - p$ $q = \frac{13}{60}$ $p = \frac{91}{300}$	B1ft B1 M1 M1 A1 A1 (6)
Notes		[12 marks]
(a)	B1 B and C seen. If they include A then B0	
(b)	1 st M1 for a correct equation for $P(C)$ using independence. 1 st A1 for $P(C) = 0.2$ correct linear equation for r or s 2 nd A1 for either $r = 0.07$ or $s = 0.28$ 2 nd M1 for using $\sum p = 1$ Allow letter r and s or their values for r and s provided they are probabilities. 3 rd A1 for both $s = 0.28$ and $r = 0.07$	
(c)	1 st B1ft NB: The quotations around the 0.07 ("0.07") imply that we fit their value for an expression (in q) for $P(B \cup C)$ ft their value of r or their "0.2" eg $0.13 + "their r" + q$ Implied by 1 st or 2 nd M1 below. 2 nd B1 for a correct expression for $P(A \cap C')$ in terms of p and q or 0.52 Implied by 1 st or 2 nd M1 below 1 st M1 for a correct use of independence (ft their probabilities), values or letters. Implied by 2 nd M1 2 nd M1 using $p + q = 0.52$ to gain a linear equation in one variable 1 st A1 for a correct fraction for q 2 nd A1 for a correct fraction for p SC: If both p and q are given as equivalent recurring decimals award A0A1 eg $0.21\dot{6}$ and $0.30\dot{3}$	



Question Number	Scheme		Marks
3 (i) (a)	$w = 0.15$		B1
	$x = 0.7 - 0.15 = 0.55$		B1
	$y = 0.65 - 0.55 = 0.1$		B1
	$z = 1 - 0.15 - 0.55 - 0.1 = 0.2$		B1
			(4)
(b)	'0.15' + '0.1' = '0.25'		B1ft
			(1)
(c)	$[P(C) \times P(O)] = '0.65' \times '0.7' \neq '0.55' [= P(C \cap O)]$ or $[P(C O)] = \frac{'0.55'}{'0.7'} \neq '0.65' [= P(C)]$ oe		M1
	'0.455' $\neq$ '0.55' or '0.7857'... $\neq$ '0.65' [So not independent]*		A1*
			(2)
3 (ii) (a)	$\left[P(F \cup H) = \frac{2}{7} + \frac{1}{4} = \right] \frac{15}{28}$		B1
			(1)
(b)	$\frac{5}{8} = \frac{2}{7} + P(G) - \frac{2}{7}P(G)$		M1
	$P(G) = \frac{\frac{5}{8} - \frac{2}{7}}{1 - \frac{2}{7}} = \frac{19}{56} \div \frac{5}{7}$		dM1
	$P(G) = \frac{19}{40}$		A1
			(3)
(c)	$\left[P(F \cap G) = \frac{2}{7} \times \frac{19}{40} = \right] \frac{19}{140}$		B1ft
			(1)
Notes			Total 12
(i)(a)	B1	$w = 0.15$ If answer is given in the script and the Venn diagram, then mark the script	
	B1	$x = 0.55$ If answer is given in the script and the Venn diagram, then mark the script	
	B1	$y = 0.1$ If answer is given in the script and the Venn diagram, then mark the script	
	B1	$z = 0.2$ If answer is given in the script and the Venn diagram, then mark the script	
(b)	B1ft	For $w + y = '0.25'$ follow through their w and their y (You will need to check for their values) provided this is a probability	
(c)	M1	For $'(x + y)' \times '(w + x)' \neq 'x'$ or $\frac{'x'}{'w + x'} \neq 'x + y'$ ft their w, x and y	
	A1*	A fully correct solution with values evaluated and no errors ft their w, x and y	
(ii) (a)	B1	For $\frac{15}{28}$ oe Allow awrt 0.536	
(b)	M1	For use of $P(F \cup G) = P(F) + P(G) - P(F) \times P(G)$	
	dM1	Dependent on M1. For a correct rearrangement to find $P(G)$ e.g. $\left(\frac{5}{8} - \frac{2}{7}\right) \div \left(1 - \frac{2}{7}\right)$ Allow $\frac{19}{56} = \frac{5}{7}P(G)$ May be implied by $\frac{19}{40}$	
	A1	For $\frac{19}{40}$ oe	
(c)	B1ft	For $\frac{19}{140}$ oe or $\frac{2}{7} \times P(G)$ evaluated correctly and where $P(G)$ is a probability	



Question	Scheme		Marks
3 (a)	$E(X) = 2a + 3 \times 0.4 + 4(0.6 - a) [= 3.6 - 2a]$		M1 A1
			(2)
(b)	$0 < a < 0.6$ oe		B1
	$2 \times 0.6 + 3 \times 0.4 [= 2.4]$ or $3.6 - 2 \times 0.6 [= 2.4]$	Alternative $0 > -2a > -1.2$ $3.6 > 3.6 - 2a > 2.4$	M1
	and $3 \times 0.4 + 4 \times 0.6 [= 3.6]$ or $3.6 - 2 \times 0 [= 3.6]$		
	$2.4 < E(X) < 3.6$		A1
			(3)
(c)	$\text{Var}(X) = E(X^2) - E(X)^2$		
	$[E(X^2) =] 4a + 3.6 + 9.6 - 16a [= 13.2 - 12a]$		M1 A1
	$\text{Var}(X) = '(13.2 - 12a)' - ('3.6 - 2a')^2$		M1
	$-4a^2 + 2.4a - 0.32 = 0$		A1
	$a = \frac{-'2.4' \pm \sqrt{'2.4'^2 - 4 \times '-'4' \times '-'0.32'}}{2 \times '-'4'}$		M1
	$a = \frac{1}{5} \quad a = \frac{2}{5}$		A1
			(6)
Notes			Total 11
(a)	M1	for an attempt to find $E(X)$ with 2 out of the 3 products correct	
	A1	for $2a + 1.2 + 4(0.6 - a)$ oe	
(b)	B1	This may be seen as two separate parts e.g. $a > 0$ and $a < 0.6$, Allow the use of $\leq$ or $\geq$ for $<$ or $>$ We allow this to be written in words e.g. a is between 0 and 0.6	
	M1	for a correct method for finding the lower and upper end of the range. May be implied by $2.4 < E(X) < 3.6$ or sight of 2.4 and 3.6	
	A1	Allow e.g. 2.4,, $3.6 - 2a$,, 3.6	
		NB $2.4 < E(X) < 3.6$ or 2.4,, $3.6 - 2a$,, 3.6 scores 3/3	
(c)	M1	An attempt at an expression for $E(X^2)$ with 2 terms correct. May be seen in an attempt at $\text{Var}(X)$	
	A1	a correct expression for $E(X^2)$ May be seen in an attempt at $\text{Var}(X)$ Does not have to be fully simplified, allow $4a + 3.6 + 9.6 - 16a$ or better	
	M1	use of $\text{Var}(X) = E(X^2) - E(X)^2$ ft their $E(X^2)$ and their part (a)	
	A1	a correct 3TQ e.g. $25a^2 - 15a + 2 = 0$	
	M1	correct method for solving their 3TQ e.g. $(5a - 2)(5a - 1) = 0$	
		May be implied by $a = \frac{1}{5}$ and $a = \frac{2}{5}$ If the 3TQ is incorrect then a correct substitution of their values into the quadratic formula (If a and c are both negative, allow the omission of negatives in $4ac$ and allow a correct single value in the denominator) or a complete method using completing the square or a correct factorisation must be seen before their values of a	
	A1	$a = \frac{1}{5}$ oe and $a = \frac{2}{5}$ oe Allow any letter for a	

Question	Scheme		Marks
4 (i)(a)	$p + q = \frac{7}{25}$ oe $q + r = \frac{1}{5}$ oe $p + r = \frac{8}{25}$ oe		M1 M1 M1
	$2p + 2q + 2r = \frac{7}{25} + \frac{1}{5} + \frac{8}{25} \left[= \frac{4}{5} \right]^*$		A1* (4)
(i)(b)	eg $p + q + r + s = 1$		M1
	$p = \frac{1}{5}$ oe $q = \frac{2}{25}$ oe $r = \frac{3}{25}$ oe $s = \frac{3}{5}$ oe		A1 A1 A1 A1
			(5)
(ii)	$\frac{x}{x+5} + \frac{5}{x} = \frac{x^2 + 5(x+5)}{x(x+5)}$ or $\frac{x}{x+5} + \frac{5}{x} = \frac{x+5-5}{x+5} + \frac{5}{x}$		M1
	$= \frac{x^2 + 5x + 25}{x^2 + 5x}$ oe or $= 1 - \frac{5}{x+5} + \frac{5}{x}$		M1
	$= 1 + \frac{25}{x^2 + 5x}$ or as $x^2 + 5x + 25 > x^2 + 5x$ $P(C) + P(D) > 1$ or As $x + 5 > x$ then		A1
	$\frac{5}{x+5} < \frac{5}{x} \Rightarrow -\frac{5}{x+5} + \frac{5}{x} > 0$ So $P(C) + P(D) > 1$		
	$P(C \cup D) > 1$ or $P(C \cap D) > 0$		A1 cso
			(4)
Notes			Total 13
NB In (i) Allow the use of exact decimals throughout and mark (a) and (b) together			
(i)(a)	M1	for $p + q = \frac{7}{25}$ oe or $p + q = P(A)$	
	M1	for $q + r = \frac{1}{5}$ oe or $q + r = P(B)$	
	M1	for $p + r = \frac{8}{25}$ oe or $p + r = P[(A \cap B') \cup (A' \cap B)]$	
	A1*	we must see $2p + 2q + 2r = \frac{7}{25} + \frac{1}{5} + \frac{8}{25}$ and no errors	
(i)(b)	M1	any correct equation involving at least two of p, q, r and s . May be implied by two correct values. Do not allow just $2p + 2q + 2r = \frac{4}{5}$ This mark may be awarded in part (a)	
	A1	for $\frac{1}{5}$ or 0.2 oe This mark may be awarded in part (a)	
	A1	for $\frac{2}{25}$ or 0.08 oe This mark may be awarded in part (a)	
	A1	for $\frac{3}{25}$ or 0.12 oe This mark may be awarded in part (a)	
	A1	for $\frac{3}{5}$ oe This mark may be awarded in part (a)	
	SC	for one correct value M0 A1 A0 A0 A0	
(ii)	M1	For an attempt to add $P(C)$ and $P(D)$ e.g. $\frac{x^2}{x(x+5)} + \frac{5(x+5)}{x(x+5)}$ May be implied by $\frac{x^2 + 5x + 25}{x^2 + 5x}$ or $1 - \frac{5}{x+5} + \frac{5}{x}$	
	M1	For $\frac{x^2 + 5x + 25}{x^2 + 5x}$ oe or $1 - \frac{5}{x+5} + \frac{5}{x}$	
	A1	for recognising that $P(C) + P(D)$ is > 1	
	A1 cso	a fully correct solution showing that C and D cannot be mutually exclusive	

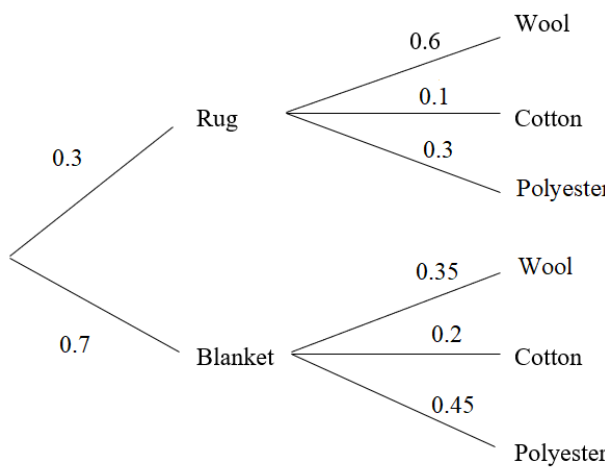
Question	Scheme		Marks
6(a)	0.16 oe		B1
			(1)
(b)	Mark parts (b) and (c) together If values are given in the diagram and the script, then the script takes precedence		
	$[P(C) =]0.04 + 0.15 + 0.12 + p [= 0.31 + p]$ $[P(S) =]0.1 + 0.15 + 0.12 + 0.23 [= 0.6]$ $[P(S \cap C) =]0.15 + 0.12 [= 0.27]$	$[P(C') =]0.1 + 0.23 + q [= 0.33 + q]$ $[P(S') =]1 - (0.12 + 0.15 + 0.1 + 0.23) [= 0.4]$ $[P(S' \cap C') =]q$	M1M1
	$("0.31" + p) \times "0.6" = "0.27" \quad \text{oe}$	$("0.33" + q) \times "0.4" = q \text{ oe}$	M1d
	$p = 0.14 \text{ oe}$	$q = 0.22 \text{ oe}$	A1
			(4)
	(c)	$q = 1 - (0.04 + 0.12 + 0.15 + 0.1 + 0.23 + "p")$ $q = 0.22 \text{ oe}$	$p = 1 - (0.04 + 0.12 + 0.15 + 0.1 + 0.23 + "q")$ $p = 0.14 \text{ oe}$
			(2)
(d)(i)	$[P((C \cup S) \cap G')] = 0.39 \text{ oe}$		B1
			(1)
(ii)	$P(C (S \cap G)) = \frac{0.15}{0.15 + 0.1}$ $= 0.6 \text{ oe}$		M1
			A1
			(2)
(e)	Number of teenagers = $\frac{76}{0.15 + "p"} \text{ oe}$		M1
	Number who don't play Scrabble = $\left(\frac{76}{0.15 + p}\right) \times 0.4 \quad (= 104.8...)$		M1
	$= 104.8... \quad \text{awrt } 105$		A1
			(3)
	Notes		Total 13
(a)	B1	correct probability	
(b)	M1	for 2 correct probability expressions	
	M1	all 3 correct probability expressions Allow $P(C) = 0.45$	
	M1d	dependent on the 1st M1 being awarded for use of $P(C \cap S) = P(C) \times P(S)$ oe or $P(C' \cap S') = P(C') \times P(S')$ ft their probabilities if labelled clearly	
	A1	for 0.14 or exact equivalent or 0.22 or exact equivalent	
(c)	M1	for a correct expression for q ft their value of p or a correct expression for p ft their value of q May be implied by a correct value for q ft their p or a correct value for p ft their q	
	A1ft	for 0.22 or exact equivalent ft their value of p or 0.14 or exact equivalent ft their value of q ($p + q = 0.36$ provided p and q are probabilities)	
(d)(i)	B1	for 0.39 or exact equivalent do not allow $0.04 + 0.12 + 0.23$	
(ii)	M1	for $\frac{0.15}{0.15 + 0.1}$	
	A1	for 0.6 or exact equivalent	
(e)	M1	Relating 76 to their $P(C \cap G)$ May be implied by awrt 262	
	M1	for number of teenagers $\times 0.4$ ft their number of teenagers e.g. $0.4 \times "262"$ provided that the number of teenagers is not 76	
	A1	awrt 105 ISW	

Question Number	Scheme	Marks
6. (a)	Centre of the disc must land at least 1 cm from each side of the rectangle i.e. inside a rectangle 3 cm long and 1 cm wide Probability disc lies inside rectangle is $\frac{3 \times 1}{5 \times 3} = \frac{1}{5}$ <u>or</u> $1 - \frac{2(1 \times 5 + 1 \times 1)}{5 \times 3}$ (oe) (*)	M1 dM1 A1cso (3)
(b)	$[\sigma_x =] \sqrt{\frac{295}{15} - \left(\frac{61}{15}\right)^2}$ or $\sqrt{3.1288...}$ $= 1.768866... \text{ awrt } \underline{1.77}$	M1 A1 (2)
(c)	$\bar{y} = 3.5 \Rightarrow \sum y = 42$, so new $\sum z = 42 + 61 [= 103]$ $\sigma_y = 2 \Rightarrow 2^2 = \frac{\sum y^2}{12} - 3.5^2$ or $2 = \sqrt{\frac{\sum y^2}{12} - 3.5^2}$ $\sum y^2 = (2^2 + 3.5^2) \times 12 [= 195]$ so new $\sum z^2 = (2^2 + 3.5^2) \times 12 + 295$ [<u>or</u> 490] New mean = $\frac{"103"}{(15+12)} = [3.8148...]$ New standard deviation = $\sqrt{\frac{"490"}{(12+15)} - "3.81..."^2} [= 1.89613...]$ New mean = awrt <u>3.81</u> new st. dev = awrt <u>1.90</u>	M1, A1 M1 A1 dM1 dM1 A1 (7)
(d)	Centre of disc must be within 1 cm of a vertex (so 4 quarter circles) So probability of disc covering a vertex is $\frac{\pi}{15}$ So an estimate for π is $15 \times 0.2216 = \underline{3.324}$	M1 A1 A1 (3)
		[15 marks]
	Notes	
MR	(a) 1 st M1 accept a suitable diagram showing “winning area” <u>or</u> equivalent in words 2 nd dM1 dep on M1 for dimensions of rectangle within which centre must lie (at least 3 or 1 seen) A1 cso for complete explanation with evidence seen for both M1 marks See next page for case of MR with $n = 15 \times 20 = 300$	
	(b) M1 for a correct expression including $\sqrt{\quad}$ allow $\sqrt{3.129}$ or better A1 for awrt 1.77 [exact surd is A0] (allow s = awrt 1.83 [calc: 1.8309508...]) Ans only 2/2	
	(c) 1 st M1 for using mean of 3.5 to get sum of 12 students e.g. 12×3.5 1 st A1 for a correct sum of $42 + 61$ <u>or</u> 103 (allow any letter). 2 nd M1 for a correct equation for $\sum y^2$ (sum of squares for the 12 students). Any letter 2 nd A1 for correct <u>expression</u> for $\sum z^2$ e.g. $= 195 + 295 [= 490]$ 3 rd dM1 dep on 1 st M1 for a correct method for finding new mean or awrt 3.81 4 th dM1 dep on 1 st and 2 nd M1s for a correct method for new st. dev. 3 rd A1 for both mean = awrt 3.81 (or 3.815) <u>and</u> st. dev = awrt 1.90	
	(d) M1 for explanation or diagram showing possible region for centre is a full circle 1 st A1 for the correct probability. Allow M1A1 for $\frac{\pi}{15}$ (o.e.) but must be in part (d) 2 nd A1 dep on M1 for estimate of 3.324 (accept 3.32 if M1A1 clearly scored)	

Minimum acceptable for 3/3 is $\pi = 15 \times 0.2216 = 3.324$

Qu 6	Scheme for MR	Marks
(a) MR $n = 300$	As for main scheme Only use this scheme for marking the MR	M1dM1 A1cso (3)
(b) $m = 240$	$[\sigma_x =] \sqrt{\frac{295}{300} - \left(\frac{61}{300}\right)^2} \text{ or } \sqrt{0.941988..}$ $= 0.9705611... \text{ awrt } \underline{0.971}$	M1 A0ft (2 – 1 = 1)
(c)	$\bar{y} = 3.5 \Rightarrow \sum y = 240 \times 3.5 = 840, \text{ so new } \sum z = 840 + 61 [= 901]$ $\sigma_y = 2 \Rightarrow 2^2 = \frac{\sum y^2}{240} - 3.5^2 \text{ or } 2 = \sqrt{\frac{\sum y^2}{240} - 3.5^2}$ $\sum y^2 = (2^2 + 3.5^2) \times 240 [= 3900] \text{ so } \sum z^2 = \sum y^2 = (2^2 + 3.5^2) \times 240 + 295$ $\text{New mean} = \frac{"901"}{(300 + 240)} = [1.66851...]$ $\text{New standard deviation} = \sqrt{\frac{"4195"}{(240 + 300)} - "1.668..."^2 [= 2.2326...]}$ $\text{New mean} = \text{awrt } \underline{1.67} \text{ new st. dev} = \text{awrt } \underline{2.23}$	M1, A0ft M1 A1ft dM1 dM1 A1ft (7 – 1 = 6)
(d)	Centre of disc must be within 1 cm of a vertex (so 4 quarter circles) So probability of disc covering a vertex is $\frac{\pi}{15}$ So an estimate for π is $15 \times 0.2216 = \underline{3.324}$	M1 A1 A1 (3) [13 marks]
Notes		
(a)	As in main scheme	
(b)	M1 for a correct expression including $\sqrt{\quad}$ allow $\sqrt{0.942}$ or better A0 for awrt 0.971 (This is A0 for misread as the first two accuracy ft marks are withheld)	
(c)	1st M1 for using mean of 3.5 to get sum of 12 students e.g. 240×3.5 1st A0 for a correct sum of $840 + 61$ or 901 (allow any letter) (This is the 2nd A0 for misread unless, of course, they didn't achieve awrt 0.971 in (b)) 2nd M1 for a correct equation for $\sum y^2$ (sum of squares for the 12 students = 240 rolls) 2nd A1ft for correct <u>expression</u> for $\sum z^2$ e.g. $= 3900 + 295 [= 4195]$ 3rd dM1 dep on 1st M1 for a correct method for finding new mean or awrt 1.67 4th dM1 dep on 1st and 2nd M1s for a correct method for new st. dev. 3rd A1ft for both mean = 1.67 <u>and</u> st. dev = awrt 2.23	
(d)	As in main scheme M1 for explanation or diagram showing possible region for centre is a full circle 1st A1 for the correct probability. Allow M1A1 for $\frac{\pi}{15}$ (o.e.) but must be in part (d) 2nd A1 dep on M1 for estimate of 3.324 (accept 3.32 if M1A1 clearly scored) Minimum acceptable for 3/3 is $\pi = 15 \times 0.2216 = 3.324$	

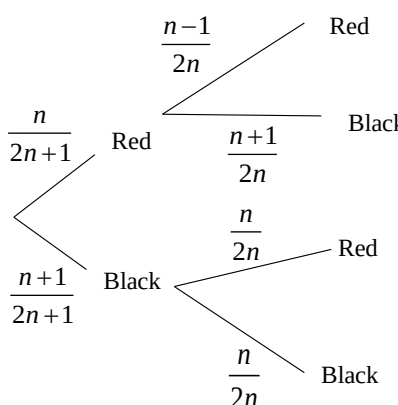
Question Number	Scheme	Marks
1. (a)		B1 B1 (2)
(b)	$P(Y) = \frac{7}{12} \times \frac{2}{11} + \frac{3}{12} \times \frac{2}{11} + \frac{2}{12} = \left\{ \frac{42}{132} \text{ or } \frac{7}{22} \right\} \quad \text{or}$ $P(\text{Yellow and two counters}) = \frac{7}{12} \times \frac{2}{11} + \frac{3}{12} \times \frac{2}{11} = \left\{ \frac{20}{132} \text{ or } \frac{5}{33} \right\}$ $\frac{P([Y \cap R] \cup [Y \cap B])}{P(Y)} = \frac{\frac{20}{132}}{\frac{42}{132}} = \frac{20}{42} \text{ or } \frac{10}{21} \text{ oe}$	M1 M1 A1 (3) [5 marks]
Notes		
(a)	1 st B1 for the remaining probs on first set of branches and at least one on 2 nd set 2 nd B1 for a fully correct tree diagram with all the correct probabilities	
(b)	1 st M1 for a correct ft expression for P(Y) or P(Yellow and two counters)ft their tree diagram eg $1 - \frac{7}{12} \times \frac{6+3}{11} - \frac{3}{12} \times \frac{7+2}{11}$ NB: The method is implied by the numbers in curly brackets but we do not need to see them to award the mark. 2 nd M1 for a correct ratio formula (symbols or words) <u>and</u> at least one correct ft prob or fully correct ft ratio. Do not follow through probabilities > 1 or < 0 A1 for $\frac{10}{21}$ or exact equivalent. (Allow 0.476190) NB if an exact correct fraction is not given and an awrt 0.476... is given it would get M1M1A0 if from correct working Generally if the answer is correct then award full marks (unless from obvious incorrect working) or notes indicate otherwise	

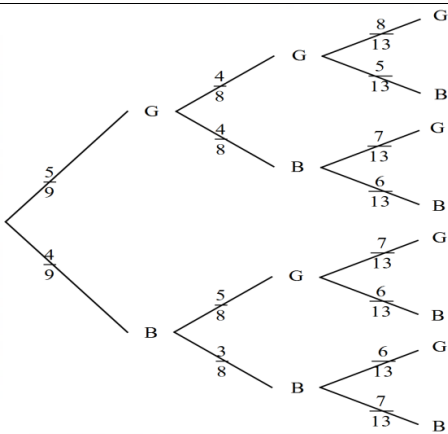
Question Number	Scheme		Marks
3(a)			B1 B1
			(2)
(b) (i)	$P(W') = 0.3 \times (0.1 + 0.3) + 0.7 \times (0.2 + 0.45)$ or $P(W') = 1 - (0.3 \times 0.6 + 0.7 \times 0.35)$ $= \underline{\underline{0.575}}$		M1 A1
			(2)
(ii)	$P(B W') = \frac{P(B \cap W')}{P(W')} = \frac{0.7 \times (0.2 + 0.45)}{0.575}$		M1
	$= \frac{91}{115}$		A1
			(2)
	Notes		Total 6
(a)	B1	At least 5 probabilities correct (allow fraction, percentage or decimal) But do not allow eg $\frac{3.5}{10}$ or 35 (without percentage symbol)	
	B1	All 8 probabilities correct (allow fraction, percentage or decimal) But do not allow eg $\frac{3.5}{10}$ or 35 (without percentage symbol)	
(b)(i)	M1	Correct probability expression ft the probabilities from their part (a)	
	A1	$\frac{23}{40}$ oe allow equivalent fraction, decimal or percentage	
(ii)	M1	Correct method for conditional probability used ft their part (a) and ft their (b)(i)	
	A1	awrt 0.791 allow awrt 79.1%	

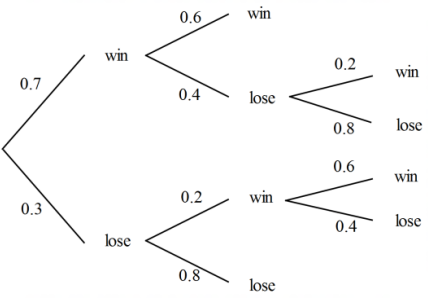
Question Number	Scheme		Marks
3 (a)	$1 - p, \frac{7}{8}$ and $\frac{9}{10}$ in the correct place on tree diagram		B1
			(1)
(b)	$\frac{1}{8}p + \frac{1}{10}(1 - p) = 0.11$		M1 A1ft
	$p = \frac{2}{5}$		A1
			(3)
(c)	$\frac{2}{5} \times \frac{1}{8} = \frac{1}{20}$		M1 A1ft
			(2)
(d)	$P(Y12 R) = \frac{\frac{2}{5} \times \frac{7}{8}}{1 - 0.11}$ or $P(Y12 R) = \frac{\frac{2}{5} \times \frac{7}{8}}{\frac{2}{5} \times \frac{7}{8} + \frac{3}{5} \times \frac{9}{10}}$		M1
	$= \frac{35}{89}$		A1
			(2)
	Notes		Total 8
(a)	B1	For a fully correct tree diagram with all 3 correct labels. Allow if $1 - p$ is seen and crossed out/replaced with a numerical probability.	
(b)	M1	For $\frac{1}{8}p$ or $\frac{1}{10}(1 - p)$ 'seen in an equation for p	
	A1ft	For a fully correct equation in p or correct ft equation based on their tree diagram	
	A1	oe correct answer scores 3 out of 3	
(c)	M1	For $p \times \frac{1}{8}$ ft their p , provided p is a probability	
	A1ft	For a correct answer ft their p , provided p is a probability. Correct answer scores 2 out of 2	
(d)	M1	For a correct ratio of probabilities. Can ft their p , provided p is a probability	
	A1	For $\frac{35}{89}$ (Allow awrt 0.393)	

Qu	Scheme	Marks
4(a)		B1B1
		(2)
(b)	$0.3 \times "0.98"$	M1
	$= 0.294$	A1
		(2)
(c)	$(0.3 \times 0.02) + ("0.45" \times "0.04") + ("0.25" \times "0.06")$	M1
	$= 0.039$	A1
		(2)
(d)	$P(C Red) = \frac{"0.25" \times "0.06"}{"0.039"} \left[= \frac{0.015}{"0.039"} \right]$	M1, M1
	$= 0.3846... \text{ or } \frac{5}{13}$	A1
		(3)
	Notes	Total 9
(a)	B1 for 0.45, 0.25 and 0.98 Allow fractions B1 0.04, 0.96 and 0.06, 0.94 Allow fractions	
(b)	M1 may fit their tree diagram if method shown $0.3 \times "$ their 0.98" A1 0.294 oe	
(c)	M1 may fit their tree diagram if method shown A1 0.039 oe	
(d)	M1 allow $\frac{p}{\text{"their part (c)"}}$ or $\frac{p}{0.039}$ where $0 < p < 1$ and $p < \text{denominator}$ and their (c) is a probability or allow $\frac{"0.25" \times "0.06"}{q}$ or $\frac{0.015}{q}$ where $0 < q < 1$ and $q > \text{numerator}$	
	M1 for $\frac{"0.25" \times "0.06"}{"0.039"}$ ft their tree diagram and their part(c) if all 3 figures shown in working. We will condone num > denom	
	A1 awrt 0.385	
	NB if correct ft on numerator and denominator leads to "num" > "denom" then max score is M0M1A0	

Question Number	Scheme							Marks
6(a)	$[10k = 1 \Rightarrow] k = 0.1$							B1
								(1)
(b)	e.g. $P(X = 1) = 0.1$ and $P(X = 2) [= F(2) - F(1)] = 0.1$							B1
	e.g. $P(X = 3) [= F(3) - F(2)] = 0.1$							M1
	X	1	2	3	4	5	6	A1
	$P(X = x)$	0.1	0.1	0.1	0.2	0.2	0.3	
								(3)
(c)	$a + a + a + b + b + b + 0.11 + 0.05 = 1 \quad [3a + 3b = 0.84]$							M1
	$a + 2a + 3a + 4b + 5b + 6b + 0.77 + 0.4 = 4.02 \quad [\Rightarrow 6a + 15b = 2.85]$							M1
	e.g. $9a = 1.35 \Rightarrow a = 0.15^*$							A1*
								(3)
(d)	$b = 0.13$							
	$E(Y^2) = 1^2 \times 0.15 + 2^2 \times 0.15 + 3^2 \times 0.15 + 4^2 \times '0.13' + 5^2 \times '0.13' + 6^2 \times '0.13' + 7^2 \times 0.11 + 8^2 \times 0.05 = [20.7]^*$							M1 A1*
								(2)
(e)	$[Var(Y) =] 20.7 - 4.02^2 [= 4.5396]$							M1
	$Var(5 - 2Y) = 4Var(Y) = 4 \times '4.5396' = 18.1584$							awrt 18.2 M1 A1
								(3)
(f)	$'0.1' \times 0.15 + '0.1' \times 0.15 = 0.03$							M1 A1
								(2)
	Notes							Total 14
(a)	B1	For $k = 0.1$ oe						
(b)	B1	For correct use of $F(x)$ to find 2 probabilities May be implied by two correct probabilities						
	M1	For correct use of $F(x)$ to find one other probability. May be implied by one other correct probability						
	A1	For a fully correct probability distribution. Need not be in a table but probabilities must be attached to the correct X values						
(c)	M1	For use of the sum of the probabilities = 1 to form a linear equation in a and b (May be implied by $3a + 3b = 0.84$)						
	M1	For use of $\sum y \times P(Y = y) = 4.02$ to form a linear equation in a and b (May be implied by $6a + 15b = 2.85$)						
	A1*	Answer is given so there must be a correct line between the 2 equations and the given answer						
(d)	M1	For finding $E(Y^2)$ with their b (At least 4 correct terms). Values for a and b must be substituted into their expression for $E(Y^2)$						
	A1*	For a fully correct expression (no incorrect working seen) eg. $14 \times 0.15 + 77 \times 0.13 + 49 \times 0.11 + 64 \times 0.05$ Allow $0.15 + 0.6 + 1.35 + 2.08 + 3.25 + 4.68 + 5.39 + 3.2$						
(e)	M1	For a correct expression for $Var(Y)$. May be implied by awrt 4.54 Allow $E(5 - 2Y) = -\frac{76}{25}$ oe and $E((5 - 2Y)^2) = \frac{137}{5}$						
	M1	For use of $4Var(Y)$ ft their $Var(Y)$ provided $Var(Y)$ is not 20.7 or 4.02 Do not allow $5 + 4Var(Y)$ Allow $Var(5 - 2Y) = \frac{137}{5} - \left(-\frac{76}{25}\right)^2$ ft their $E(5 - 2Y)$ and their $E((5 - 2Y)^2)$						
	A1	awrt 18.2						
(f)	M1	For use of $P(X = 1) \times P(Y = 2) + P(X = 2) \times P(Y = 1)$ ft their X distribution probabilities						
	A1	Cao						

Question Number	Scheme		Marks
7 (a)		$\frac{n}{2n+1}$ and $\frac{n+1}{2n+1}$ in the correct places on the tree diagram	B1
		$\frac{n-1}{2n}$ and $\frac{n+1}{2n}$ in the correct places on the tree diagram	B1
		$\frac{n}{2n}$ and $\frac{n}{2n}$ in the correct places on the tree diagram	B1
			(3)
(b)	$\left(\frac{n}{2n+1} \times \frac{n+1}{2n} + \frac{n+1}{2n+1} \times \frac{n}{2n} \right)$		M1
	$= \frac{2n(n+1)}{2n(2n+1)} = \frac{n+1}{2n+1} *$		A1*
			(2)
(c)	$\frac{n+1}{2n+1} = \frac{25}{49} \Rightarrow n = 24$ So 49 counters in the box		M1 A1
			(2)
(d)	$\frac{\frac{25}{49} \times \frac{24}{48}}{\frac{25}{49}} = \frac{1}{2}$		M1 A1
			(2)
Notes			Total 9
(a)	B1	For $\frac{n}{2n+1}$ and $\frac{n+1}{2n+1}$ in the correct places on the tree diagram	
	B1	For $\frac{n-1}{2n}$ and $\frac{n+1}{2n}$ in the correct places on the tree diagram	
	B1	For $\frac{n}{2n}$ and $\frac{n}{2n}$ in the correct places on the tree diagram. Allow $\frac{1}{2}$ for $\frac{n}{2n}$ in both places	
(b)	M1	For use of $P(\text{Red}) \times P(\text{Black}) + P(\text{Black}) \times P(\text{Red})$ ft their tree diagram	
	A1*	Answer is given so no incorrect working can be seen. Must have at least one correct line of working between M1 and the given answer.	
(c)	M1	For solving to find $n = 24$	
	A1	Cao	
(d)	M1	For a correct ratio ft their n and their tree diagram	
		Allow a correct ratio in terms of n e.g. $\frac{\frac{n+1}{2n+1} \times \frac{n}{2n}}{\frac{n+1}{2n+1}}$ oe ft their tree diagram for the numerator	
	A1	For 0.5 (Working must be seen)	

Question	Scheme		Marks
2 (a)	 $\frac{5}{8} \& \frac{3}{8}$ $\frac{8}{13} \& \frac{5}{13}$ $\frac{7}{13} \& \frac{6}{13}$		B1 B1 B1
			(3)
(b)	$\frac{5}{9} \times \frac{4}{8} + \frac{4}{9} \times \frac{5}{8} = \frac{5}{9}$ oe		M1 A1
			(2)
(c)	$\frac{5}{9} \times \frac{4}{8} \times \frac{8}{13} + \frac{4}{9} \times \frac{3}{8} \times \frac{7}{13} = \frac{61}{234}$ oe		M1 A1
			(2)
(d)	$\frac{\frac{5}{9} \times \frac{4}{8} \times \frac{8}{13}}{\frac{61}{234}} = \frac{\frac{20}{61}}{\frac{61}{234}} = \frac{40}{61}$ oe		M1 A1ft A1
			(3)
	Notes		Total 10
(a)	B1	for $\frac{5}{8} \& \frac{3}{8}$ in the correct place on the 2 nd branches Allow 0.625 & 0.375 or 62.5% & 37.5%	
	B1	for $\frac{8}{13} \& \frac{5}{13}$ in the correct place on the 3 rd branches Allow awrt 0.615 & awrt 0.385 or awrt 61.5% & awrt 38.5%	
	B1	for $\frac{7}{13} \& \frac{6}{13}$ in both correct places on the 3 rd branches Allow awrt 0.538 & awrt 0.462 or awrt 53.8% or awrt 46.2%	
(b)	M1	for $\frac{5}{9} \times \frac{4}{8} + \frac{4}{9} \times \frac{5}{8}$, ft their tree diagram provided these are probabilities Allow $\frac{5}{9} \times \frac{4}{8} \times \frac{7}{13} + \frac{5}{9} \times \frac{4}{8} \times \frac{6}{13} + \frac{4}{9} \times \frac{5}{8} \times \frac{7}{13} + \frac{4}{9} \times \frac{5}{8} \times \frac{6}{13}$	
	A1	$\frac{5}{9}$ oe Allow awrt 0.556 or awrt 55.6%	
(c)	M1	for $\frac{5}{9} \times \frac{4}{8} \times \frac{8}{13} + \frac{4}{9} \times \frac{3}{8} \times \frac{7}{13}$ ft their tree diagram provided these are probabilities	
	A1	$\frac{61}{234}$ oe Allow awrt 0.261 or awrt 26.1%	
(d)	M1	for $\frac{\text{a probability}}{\text{part (c)}}$ where numerator < denominator and $0 < \text{part (c)} < 1$	
	A1ft	for finding the correct numerator Allow awrt 0.171 or awrt 17.1% or ft their tree diagram If the answer is incorrect then working must be shown	
	A1	$\frac{40}{61}$ oe Allow awrt 0.656 or awrt 65.6%	

Question Number	Scheme		Marks
1 (a)			B1 B1 B1
(b)	$0.7 \times 0.6 = 0.42$ oe		(3) M1 A1
(c)	$'0.42' + (0.7 \times '0.4' \times '0.2') + ('0.3' \times '0.2' \times '0.6') = 0.512$ oe		(2) M1 A1
(d)	$\frac{'0.42'}{'0.512'} = 0.8203... \quad \text{oe} \quad \text{awrt } 0.820$		(2) M1 A1ft
(e)	$\frac{'0.42' + (0.7 \times '0.4' \times '0.2')}{0.7} = 0.68$ oe or $0.6 + '0.4' \times '0.2' = 0.68$ oe		(2) M1 A1
Notes			Total 11
(a)	B1	For 0.3 in the correct place on the first branch and 0.4 in the correct place on the second branch	
	B1	For 0.2 and 0.8 in the correct place in the second branch	
	B1	For 0.2, 0.8, 0.6 and 0.4 in the correct place in the third branch	
		NB ISW any extra branches drawn on the tree diagram	
(b)	M1	For 0.7×0.6	
	A1	Cao	
(c)	M1	For $'0.42' + (0.7 \times '0.4' \times '0.2') + ('0.3' \times '0.2' \times '0.6')$ Follow through part (b) and their tree diagram	
	A1	Cao	
(d)	M1	For $\frac{\text{part (b)}}{\text{part (c)}}$ provided the answer is a probability or ft their tree diagram	
	A1ft	awrt 0.820 or ft part (b) and part (c) provided the answer is a probability or ft their tree diagram. Allow 0.82 If ft and a decimal answer is given then this must be at least 3sf	
(e)	M1	For a correct ratio of probabilities. Follow through their part (b) and their tree diagram or $0.6 + '0.4' \times '0.2'$ ft their tree diagram	
	A1	Cao Allow 0.680	

Question Number	Scheme	Marks
2. (a)		B1 B1
(b)	$P(W) = 0.4p + 0.35q + "0.25" \times 0.4 \quad [= 0.4p + 0.35q + 0.1]$	(2) B1ft
(c)	Correct expression: $P(W \cap V) = "0.1" = "0.25" \times P(W)$ <u>or</u> $P(W) = P(W V) = 0.4$ $0.1 = 0.25(0.4p + 0.35q + 0.25 \times 0.4)$ <u>or</u> $0.4p + 0.35q + 0.25 \times 0.4 = 0.4$	M1 A1 (2)
(d)	$\frac{7}{30} = \frac{0.35(1-q)}{"P(J)"}$ Since V and W are independent so are V and $W' = J$ so $P(J) = 0.6$ <u>or</u> sub $P(J) = 1 -$ their (b) to get an equation in p and q [May see $8p - 23q + 12 = 0$] [So $1 - q = \frac{2}{3} P(J)$ therefore] <u>$q = 0.6$</u> $8p + 7 \times "0.6" = 6$ So <u>$p = 0.225$</u> or $\frac{9}{40}$	M1 dM1 A1 ddM1 A1 (5)
(e)	$\{P(V W) = P(V) = 0.25 \text{ (since independent) and } P(M W) = 0.225 (= p)\}$ $P(F W) = \frac{0.35 \times "0.6"}{"0.4"} \text{ or } \frac{0.35q}{(b)}; = \frac{21}{40} \text{ or } 0.525$ [Since this prob > 0.5 therefore it must be the largest] so conclusion <u>is</u> correct Allow B1ft for comparing 3 calculated probs of the form $P(M \cap W)$ needn't be correct ft	M1 ; A1 B1ft (3)
Notes		
(a)	1 st B1 0.25 for $P(V)$ 2 nd B1 for correct probabilities on 2 nd branches $(1 - p)$, $(1 - q)$ [allow their values] and 0.6	
(b)	B1ft for a correct expression using their values from tree diagram	
(c)	M1 for sight or use of a correct expression in V and W or correct equation in p and q (ft their part (b)) A1 for a fully correct equation (needn't be simplified) [may see $0.4p + 0.35q = 0.3$ <u>or</u> $8p + 7q = 6$]	
(d)	1 st M1 for using given conditional probability to form an equation in q and $P(J)$ using $\frac{7}{30}$ 2 nd dM1 (dep on 1 st M1) for a getting $P(J) = 0.6$ <u>or</u> sub $1 -$ their (b) and get 2 nd equation in p and q 1 st A1 for $q = 0.6$ [NB must be $q = 0.6$ not just $P(J) = 0.6$] May see after 3 rd M1 for solving with p 3 rd ddM1(dep on both Ms) for seeing substitution of their 1 st value to find the 2 nd value (p or q) Allow ft of their p or q in one of their equations provided p and q both lie in $(0, 1)$ 2 nd A1 for $p = 0.225$ or exact equivalent After the 2 nd M1, sight of $p = 0.225$ and $q = 0.6$ earns the final 3 marks	
(e)	M1 for a method for finding $P(F W)$ A1 for a correct value $\frac{21}{40}$ or exact equivalent B1ft for a correct conclusion based on enough probs found ft their probabilities	

Question Number	Scheme	Marks										
4. (a)	Tree diagram showing probabilities for two bags (A and B) containing balls of different colors (Red and Yellow).	B1 B1 B1 (3)										
(b)	[Cases RYY or YRY or YYR] Prob = $\frac{2}{3} \times \frac{1}{5} \times \frac{1}{8} + \frac{1}{3} \times \frac{4}{5} \times \frac{1}{8} + \frac{1}{3} \times \frac{1}{5} \times \frac{6}{8}$ $[= \frac{1}{120}(2+4+6) \text{ or } (0.0166...+0.033...+0.05)] = \frac{12}{120} \text{ or } \underline{\underline{\frac{1}{10}}} (*)$	M1 A1ft A1*cso (3)										
(c)	$[P(RYY RYY \text{ or } YRY \text{ or } YYR) =] \frac{ \text{"}\frac{2}{3} \times \frac{1}{5} \times \frac{1}{8}\text{"} }{ \frac{1}{10} }$ $= \underline{\underline{\frac{1}{6}}}$	M1 A1 (2)										
(d)	<table><tr><td>x</td><td>0</td><td>1</td><td>2</td><td>3</td></tr><tr><td>$P(X=x)$</td><td>$\frac{64}{120}$ or $\frac{8}{15}$</td><td>$\frac{42}{120}$ or $\frac{7}{20}$</td><td>$[\frac{1}{10}]$</td><td>$\frac{2}{120}$ or $\frac{1}{60}$</td></tr></table>	x	0	1	2	3	$P(X=x)$	$\frac{64}{120}$ or $\frac{8}{15}$	$\frac{42}{120}$ or $\frac{7}{20}$	$[\frac{1}{10}]$	$\frac{2}{120}$ or $\frac{1}{60}$	B1 M1 A1 (3)
x	0	1	2	3								
$P(X=x)$	$\frac{64}{120}$ or $\frac{8}{15}$	$\frac{42}{120}$ or $\frac{7}{20}$	$[\frac{1}{10}]$	$\frac{2}{120}$ or $\frac{1}{60}$								
(e)	$[E(X) =] \frac{1}{120}(0 + \text{"}42\text{"} + \text{"}2 \times 12\text{"} + \text{"}3 \times 2\text{"})$ $= \frac{72}{120} \text{ or } \underline{0.6}$	M1 A1 (2)										
Notes												
(a)	1st B1 completing the structure of branches: 2, 4 then 7 or 8 and suitable labels e.g. Y or R' 2nd B1 correct probabilities for at least bag A and bag B. Allow exact decimals 3rd B1 for a fully correct tree diagram. Condone missing 0 as probability. Allow exact decimals											
(b)	1st M1 for at least one correct product of 3 probabilities (ft their tree diagram) 1st A1ft for all 3 products of 3 probabilities added (no extras) (ft their tree diag.) 2nd A1*cso for fully correct solution with no incorrect statements seen											
(c)	M1 for a ratio of probabilities with denominator of 0.1 and numerator $\frac{1}{60}$ oe or the product of 3 probabilities seen from their tree diagram representing $P(RYY)$ provided num < 0.1 A1 for $\frac{1}{6}$ or exact equivalent											
(d)	B1 for a correct sample space i.e. $\{0, 1, 2, 3\}$ Allow extras if they have a probability of 0. M1 for at least 1 correct value of x and associated probability (excluding $x = 2$) [ft their tree] A1 for a fully correct probability distribution											
(e)	M1 for attempt at a correct expression (at least 2 correct ft part(d) non-zero products) A1 for 0.6 or any exact equivalent											

Question Number	Scheme	
7(a)		B1 M1A1 (3)
(b)	$\left(\frac{3}{9} \times \frac{6}{8} + \frac{6}{9} \times \frac{3}{8} \right), \quad = \frac{1}{2} \text{ oe}$	M1, A1 (2)
(c)	$1 - \left(\frac{6}{9} \times \frac{5}{8} \right) \text{ or } \left(\frac{3}{9} + \frac{6}{9} \times \frac{3}{8} \right), \quad = \frac{7}{12} \text{ oe}$	M1, A1 (2)
(d)	$\frac{\frac{3}{9} \times \frac{2}{8}}{\frac{7}{12}}, \quad = \frac{1}{7} \text{ oe}$	M1, A1 (2)
(e)	$\frac{\frac{1}{2}n}{n} \times \frac{\frac{1}{2}n-1}{n-1} \times \frac{\frac{3}{8}n}{n-2} \times \frac{\frac{1}{8}n}{n-3} = \frac{3}{235} \quad \left \quad \frac{4x}{8x} \times \frac{4x-1}{8x-1} \times \frac{3x}{8x-2} \times \frac{x}{8x-3} = \frac{3}{235} \right.$	M1M1
	$\frac{3}{128} n^3 \left(\frac{1}{2}n - 1 \right) = \frac{3}{235} n(n-1)(n-2)(n-3) \left[\rightarrow 63n^3 - 3198n^2 + 8448n - 4608 = 0 \right]$	dM1
	$\left[235n^2 = 256(n-1)(n-3) \Rightarrow \right] 21n^2 - 1024n + 768 = 0$	A1
	<u>or</u> $\left[(3n-6)(21n^2 - 1024n + 768) \right] \left[\Rightarrow (n \neq 2 \therefore) \right] 21n^2 - 1024n + 768 = 0$	(4)
	Notes	Total 13
(a)	B1 1 st branches correct oe allow 0.3 and 0.6	
	M1 for one correct 2 nd branch 2/8 and 6/8 oe or 3/8 and 5/8 oe	
	A1 for both correct 2 nd branches 2/8 and 6/8 and 3/8 and 5/8 oe	
(b)	M1 for adding the two correct products of probabilities ft their probabilities	
	A1 0.5 oe Correct answer from no obvious incorrect working scores M1A1	
(c)	M1 correct method used. ft their probabilities	
	A1 allow awrt 0.583	
(d)	M1 for $\frac{p}{\frac{7}{12}}$ or $\frac{n}{7}$ where $n < 7$. num>denom is M0. Indeped. e.g. $\frac{\frac{3}{9} \times \frac{2}{8} \times \frac{7}{12}}{\frac{7}{12}}$ is M0	
	A1 allow awrt 0.143	
(e)	M1 for setting up the product of 4 probabilities with all of the denominators correct and equating to 3/235 For the first term allow 1/2 oe (condone RHS method in terms of n)	
	M1 a fully correct equation (condone RHS method in terms of n)	
	dM1 (dep on 2nd M mark) for forming a correct equation in terms of n removing all terms in n from the denominator. For RHS method, only award if x is replaced by $\frac{n}{8}$	
	A1 (dep on all M marks) for a correct equation with $b = -1024$ and $c = 768$	
NB:	Trial and improvement method $\rightarrow n = 48$ satisfies the given conditions is M0M0M0A0	