**1.** Julie does a statistical experiment. She throws a dice 600 times.
She scores six 200 times.

(a) Is the dice fair? Explain your answer.

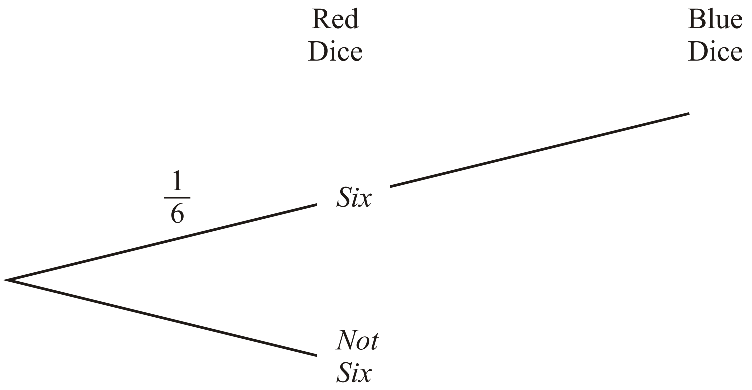
..........................................................................................................................

..........................................................................................................................

**(1)**

Julie then throws a fair red dice once and a fair blue dice once.

(b) Complete the probability tree diagram to show the outcomes.
Label clearly the branches of the probability tree diagram.
The probability tree diagram has been started in the space below.




**(3)**
**(Total 4 marks)**

**2.** A bag contains 3 black beads, 5 red beads and 2 green beads.
Gianna takes a bead at random from the bag, records its colour and replaces it.
She does this two more times.

Work out the probability that, of the three beads Gianna takes, exactly two are the same colour.

..................................

**(Total 5 marks)**

**3.** Julie does a statistical experiment. She throws a dice 600 times.
She scores six 200 times.

(a) Is the dice fair? Explain your answer.

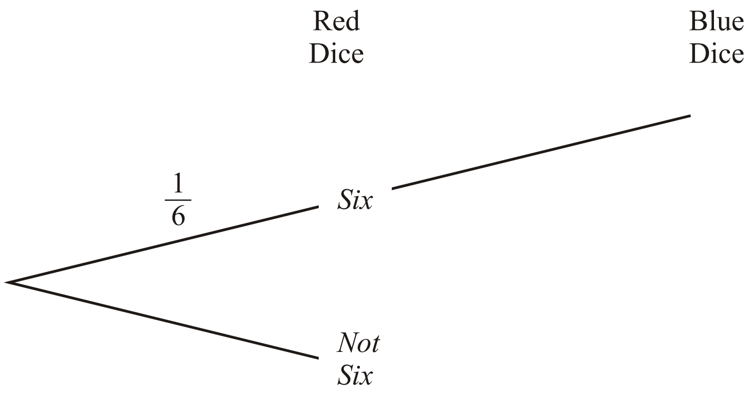
.....................................................................................................................................

.....................................................................................................................................

**(1)**

Julie then throws a fair red dice once and a fair blue dice once.

(b) Complete the probability tree diagram to show the outcomes.
Label clearly the branches of the probability tree diagram.
The probability tree diagram has been started in the space below.




**(3)**

(c) (i) Julie throws a fair red dice once and a fair blue dice once. Calculate the probability that Julie gets a six on both the red dice and the blue dice.

....................................

(ii) Calculate the probability that Julie gets at least one six.

....................................

**(5)**
**(Total 9 marks)**

**4.** The probability that Betty will be late for school tomorrow is 0.05
The probability that Colin will be late for school tomorrow is 0.06

The probability that both Betty and Colin will be late for school tomorrow is 0.011

Fred says that the events 'Betty will be late tomorrow' and 'Colin will be late tomorrow' are independent.

Justify whether Fred is correct or not.

.....................................................................................................................................

.....................................................................................................................................

.....................................................................................................................................

**(Total 2 marks)**

**5.** Mathstown College has 500 students, all of them in the age range 16 to 19.
The incomplete table shows information about the students.

| Age (years) | Number of male students | Number of female students |
|---|---|---|
| 16 | 50 | 30 |
| 17 | 60 | 40 |
| 18 | 76 | 54 |
| 19 | | |

A newspaper reporter is carrying out a survey into students' part-time jobs.
She takes a sample, stratified both by age and by gender, of 50 of the 500 students.

(a) Calculate the number of 18 year old male students to be sampled.

..............................

**(3)**

In the sample, there are 9 female students whose age is 19 years.

(b) Work out the least number of 19 year old female students in the college.

..............................

**(2)**

A newspaper photographer is going to take photographs of two students from Mathstown College.

He chooses
one student at random from all of the 16 year old students and
one student at random from all of the 17 year old students.

(c) Calculate the probability that he will choose two female students.

..............................

**(3)**
**(Total 8 marks)**

**6.** Joan has two boxes of chocolates.
The boxes are labelled **A** and **B**.

Box **A** contains 15 chocolates. There are 6 plain, 4 milk and 5 white chocolates.
Box **B** contains 12 chocolates. There are 4 plain, 3 milk and 5 white chocolates.

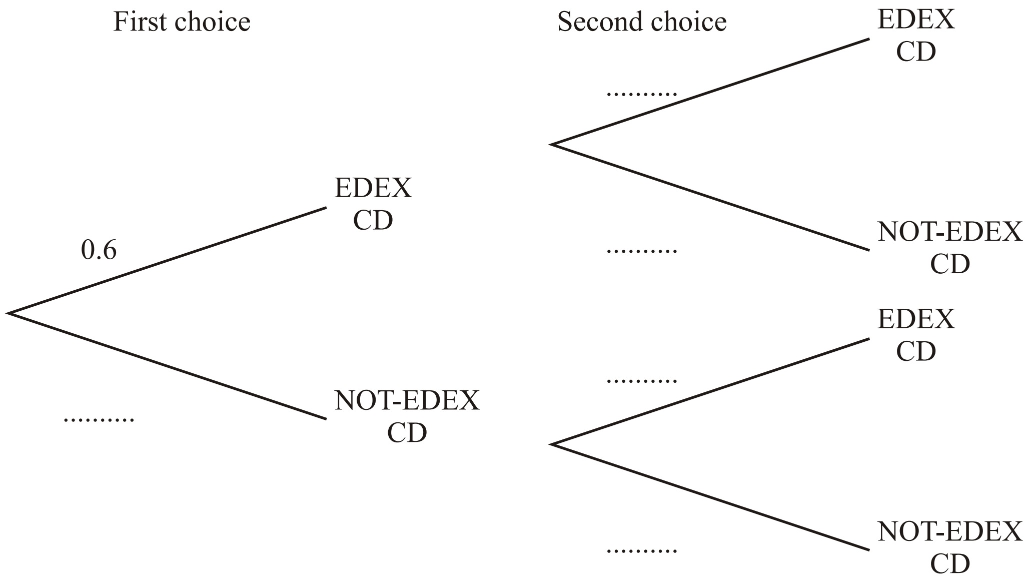
Joan takes one chocolate at random from each box.
Work out the probability that the two chocolates Joan takes are not of the same type.

..................................
**(Total 4 marks)**

**7.** Amy has 10 CDs in a CD holder.
Amy's favourite group is Edex.
She has 6 Edex CDs in the CD holder.

Amy takes one of these CDs at random.
She writes down whether or not it is an Edex CD.
She puts the CD back in the holder.
Amy again takes one of these CDs at random.

(a) Complete the probability tree diagram.




**(2)**

Amy had 30 CDs.
The mean playing time of these 30 CDs was 42 minutes.

Amy sold 5 of her CDs.
The mean playing time of the 25 CDs left was 42.8 minutes.

(b) Calculate the mean playing time of the 5 CDs that Amy sold.

......................... minutes

**(3)**
**(Total 5 marks)**

**8.** The probability that a biased dice will land on a four is 0.2

Pam is going to roll the dice 200 times.

The probability that a biased dice will land on a six is 0.4
Ted rolls the biased dice once.

Work out the probability that the dice will land on either a four or a six.

..........................

**(Total 2 marks)**

**9.** (a) (ii) Factorise $2x^2 - 35x + 98$

....................................

(ii) Solve the equation $2x^2 - 35x + 98 = 0$

....................................

**(3)**

A bag contains ($n$ + 7) tennis balls.
$n$ of the balls are yellow.
The other 7 balls are white.

John will take at random a ball from the bag.
He will look at its colour and then put it back in the bag.

(b) (i) Write down an expression, in terms of $n$, for the probability that John will take a white ball.

....................................

Bill states that the probability that John will take a white ball is $\frac{2}{5}$

(ii) Prove that Bill's statement cannot be correct.

**(3)**

After John has put the ball back into the bag, Mary will then take at random a ball from the bag. She will note its colour.

(c) Given that the probability that John and Mary will take balls with **different** colours is $\frac{4}{9}$, prove that $2n^2 - 35n + 98 = 0$

**(5)**

(d) Using your answer to part (a) (ii) or otherwise, calculate the probability that John and Mary will both take white balls.

....................................

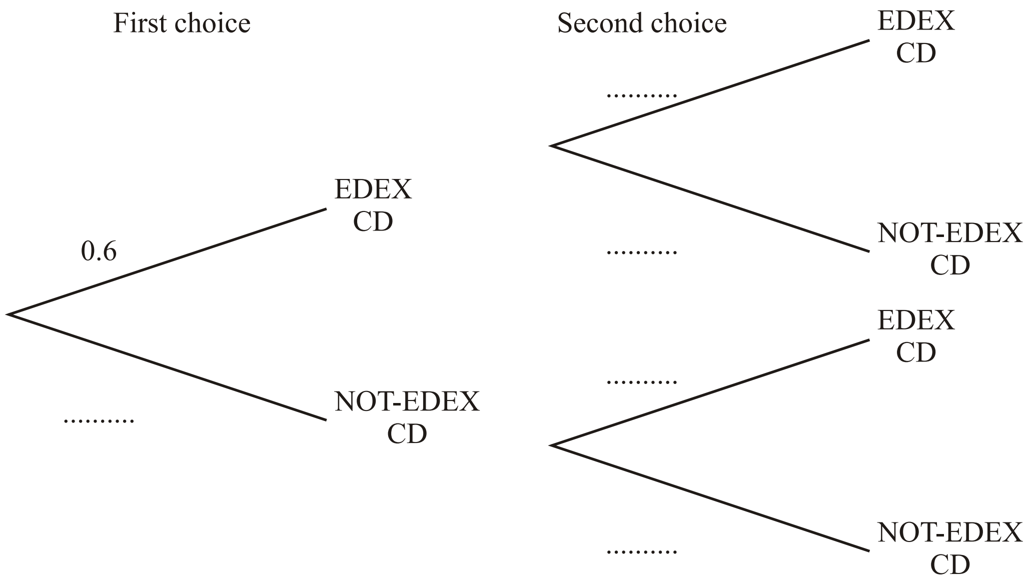
**(2)**

**(Total 13 marks)**

**10.** Amy has 10 CDs in a CD holder.
Amy's favourite group is Edex.
She has 6 Edex CDs in the CD holder.

Amy takes one of these CDs at random.
She writes down whether or not it is an Edex CD.
She puts the CD back in the holder.
Amy again takes one of these CDs at random.

(a) Complete the probability tree diagram.




**(2)**

(b) Find the probability that Amy will pick two Edex CDs.

.....................

**(2)**

Amy had 30 CDs.
The mean playing time of these 30 CDs was 42 minutes.

Amy sold 5 of her CDs.
The mean playing time of the 25 CDs left was 42.8 minutes.

(c) Calculate the mean playing time of the 5 CDs that Amy sold.

......................... minutes

**(3)**
**(Total 7 marks)**

**11.** Tony throws a biased dice 100 times.
The table shows his results.

| Score | Frequency |
|---|---|
| 1 | 12 |
| 2 | 13 |
| 3 | 17 |
| 4 | 10 |
| 5 | 18 |
| 6 | 30 |

He throws the dice once more.

(a) Find an estimate for the probability that he will get a 6.

.....................................

**(1)**

Emma has a biased coin.
The probability that the biased coin will land on a head is 0.7
Emma is going to throw the coin 250 times.

(b) Work out an estimate for the number of times the coin will land on a head.

.....................................

**(2)**
**(Total 3 marks)**

**12.** In a game of chess, you can win, draw or lose.

Gary plays two games of chess against Mijan.

The probability that Gary will win any game against Mijan is 0.55
The probability that Gary will win draw game against Mijan is 0.3

(a) Work out the probability that Gary will win **exactly** one of the two games against Mijan.

..................................

**(3)**

In a game of chess, you score

1 point for a win
$\frac{1}{2}$ point for a draw,
0 points for a loss.

(b) Work out the probability that after two games, Gary's total score will be the same as Mijan's total score.

..................................

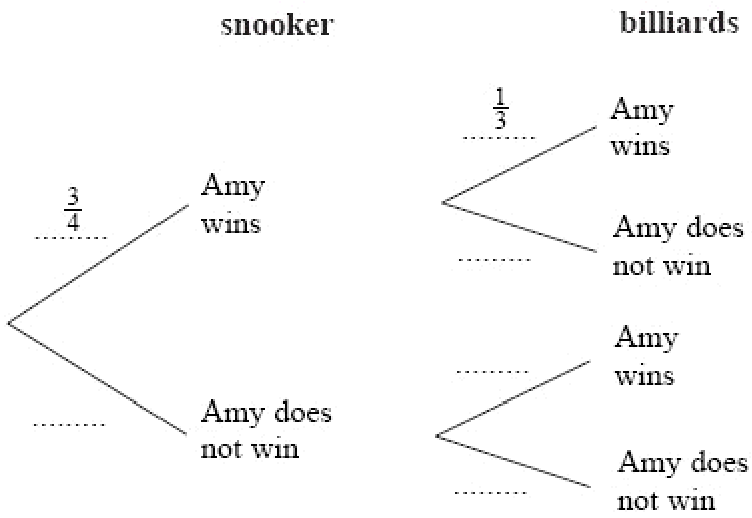
**(3)**
**(Total 6 marks)**

**13.** Amy is going to play one game of snooker and one game of billiards.

The probability that she will win the game of snooker is $\frac{3}{4}$

The probability that she will win the game of billiards is $\frac{1}{3}$

Complete the probability tree diagram.



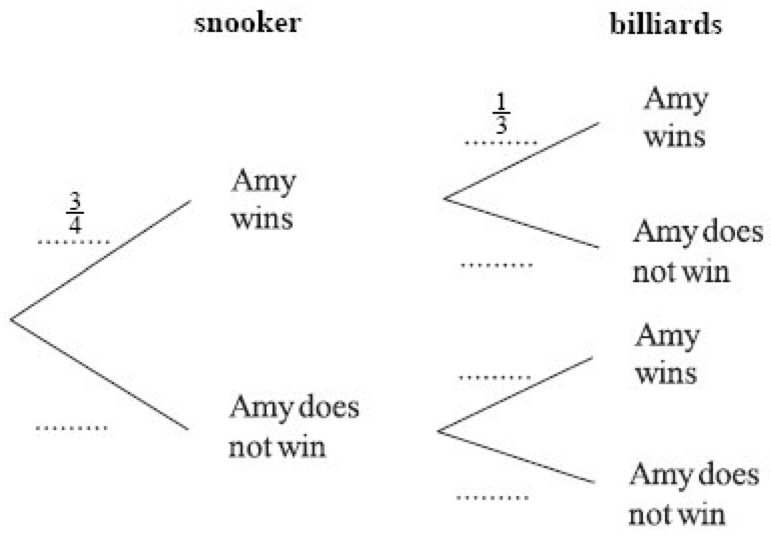

**(Total 2 marks)**

**14.** Amy is going to play one game of snooker and one game of billiards.

The probability that she will win the game of snooker is $\frac{3}{4}$

The probability that she will win the game of billiards is $\frac{1}{3}$

(a) Complete the probability tree diagram.




**(2)**

(b) Work out the probability that Amy will win **exactly** one game.

…………………….

**(3)**

Amy played one game of snooker and one game of billiards on a number of Fridays.
She won at **both** snooker and billiards on 21 Fridays.

(c) Work out an estimate for the number of Fridays on which Amy did not win either game.

…………………….

**(3)**
**(Total 8 marks)**

**15.** Jeremy designs a game for a school fair.

He has two 5-sided spinners.

The spinners are equally likely to land on each of their sides.

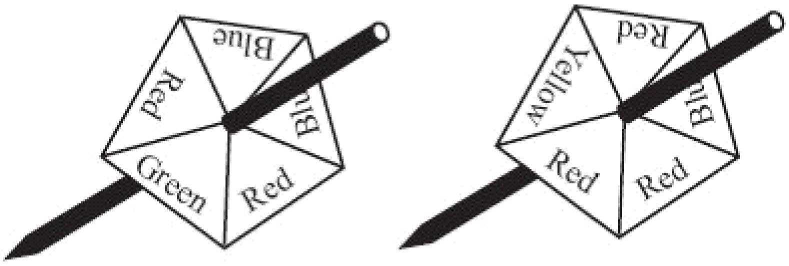
One spinner has 2 red sides, 1 green side and 2 blue sides.

The other spinner has 3 red sides, 1 yellow side and 1 blue side.

(a) Calculate the probability that the two spinners will land on the same colour.

…………………….

**(3)**




The game consists of spinning each spinner once.

It costs 20p to play the game.

To win a prize both spinners must land on the same colour.

The prize for a win is 50p.

100 people play the game.

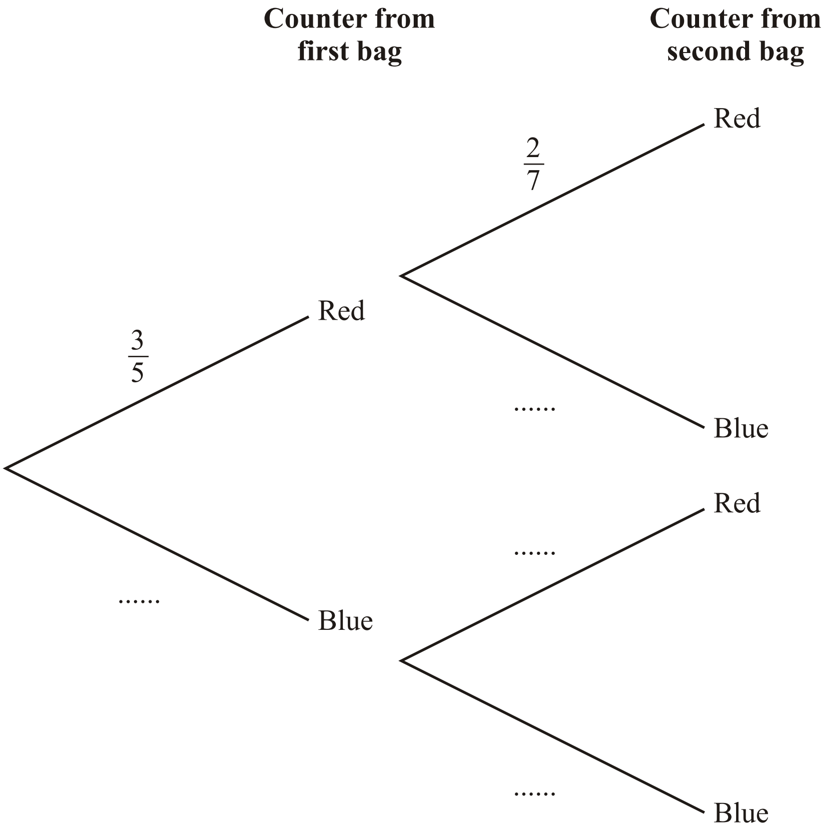
(b) Work out an estimate of the profit that Jeremy should expect to make.

£…………………
**(2)**
**(Total 5 marks)**

**16.** Loren has two bags.
The first bag contains 3 red counters and 2 blue counters.
The second bag contains 2 red counters and 5 blue counters.

Loren takes one counter at random from each bag.

Complete the probability tree diagram.

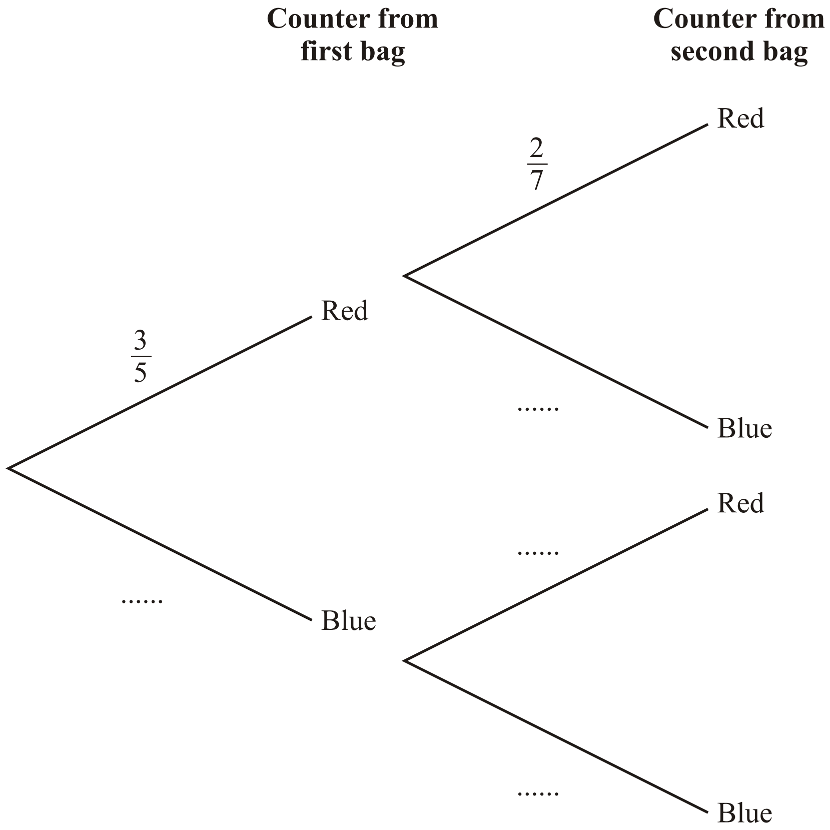



**(Total 2 marks)**

**17.** Loren has two bags.
The first bag contains 3 red counters and 2 blue counters.
The second bag contains 2 red counters and 5 blue counters.

Loren takes one counter at random from each bag.

(a) Complete the probability tree diagram.




**(2)**

(b) Work out the probability that Loren takes one counter of each colour.

...............................................

**(3)**
**(Total 5 marks)**

**18.** (a) Solve the equation $19x^2 - 124x - 224 = 0$

$x$ = .......................... , $x$ = ..........................

**(3)**

A bag contains red counters and blue counters and white counters.

There are $n$ red counters.
There are 2 more blue counters than, red counters.
The number of white counters is equal to the total number of red counters and blue counters.

(b) Show that the number of counters in the bag is $4(n + 1)$

**(1)**

Bob and Ann play a game.

Bob will take a counter at random from the bag.
He will record the colour and put the counter back in the bag.
Ann will then take a counter at random from the bag.
She will record its colour.

The probability that Bob's counter is red and Ann's counter is **not** red is $\frac{14}{81}$

(c) Prove that $19n^2 - 124n - 224 = 0$

**(5)**

(d) Using your answer to part (a), or otherwise, show that the number of counters in the bag is 36

**(1)**

Bob and Ann play the game with all 36 counters in the bag.

(e) Calculate the probability that Bob and Ann will take counters with **different** colours.

.....................................

**(3)**

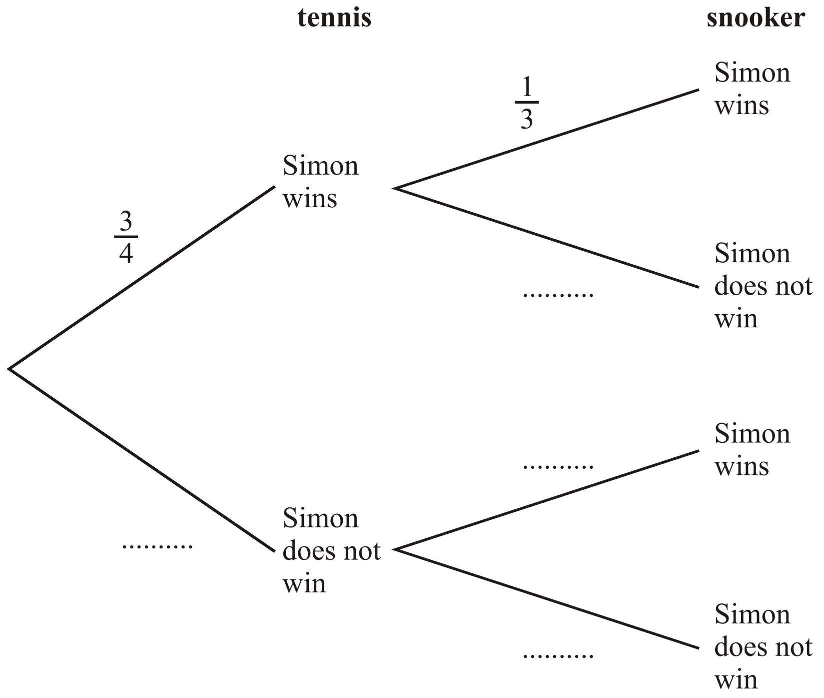
**(Total 13 marks)**

**19.** Simon plays one game of tennis and one game of snooker.

The probability that Simon will win at tennis is $\frac{3}{4}$

The probability that Simon will win at snooker is $\frac{1}{3}$

Complete the probability tree diagram.



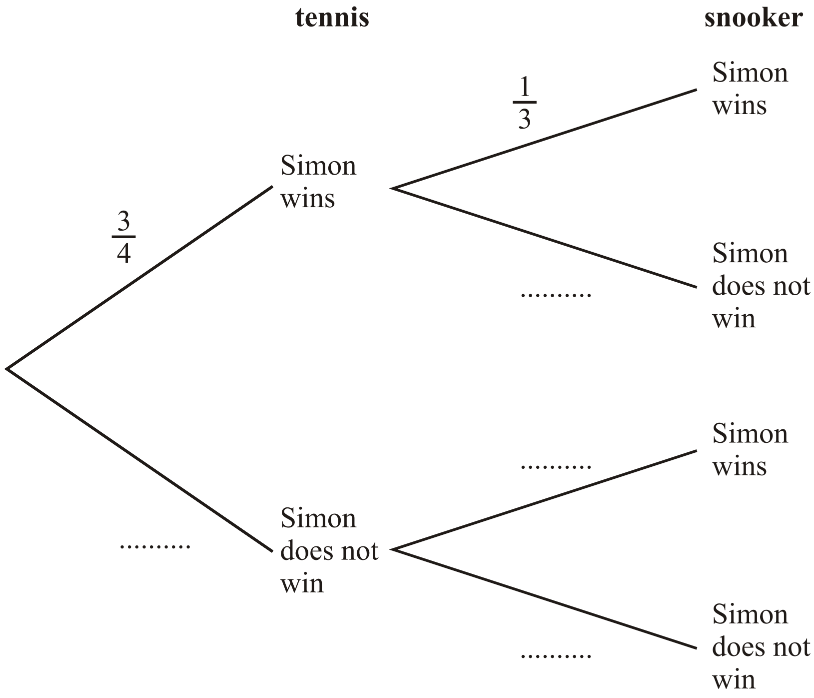

**(Total 2 marks)**

**20.** Simon plays one game of tennis and one game of snooker.

The probability that Simon will win at tennis is $\frac{3}{4}$

The probability that Simon will win at snooker is $\frac{1}{3}$

(a) Complete the probability tree diagram below.




**(2)**

(b) Work out the probability that Simon wins both games.

.....................................

**(2)**

(c) Work out the probability that Simon will win only one game.

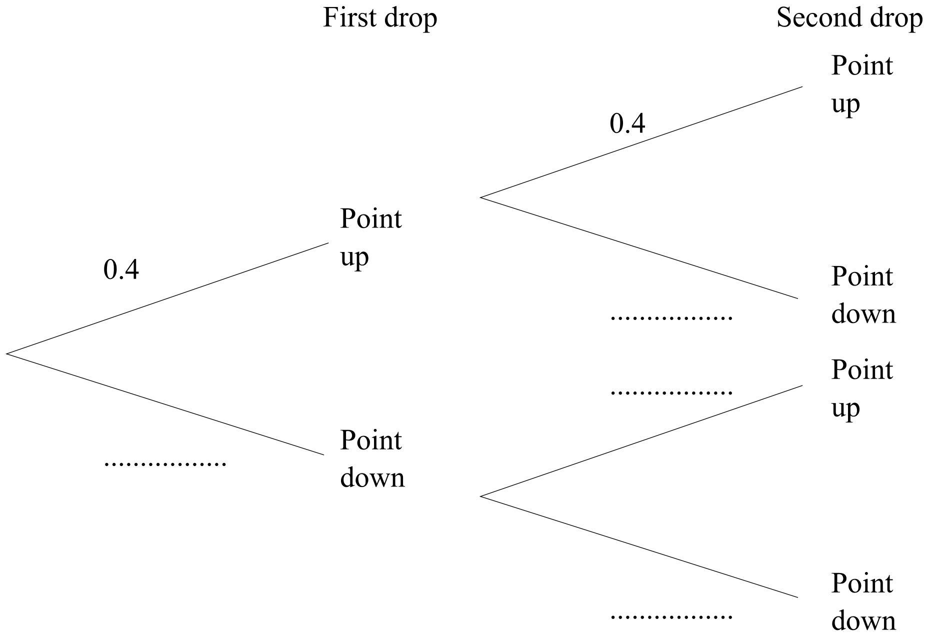
.....................................

**(3)**
**(Total 7 marks)**

**21.** Mary has a drawing pin.
When the drawing pin is dropped it can land either 'point up' or 'point down'.
The probability of it landing 'point up' is 0.4

Mary drops the drawing pin twice.

(a) Complete the probability tree diagram.




**(2)**

(b) Work out the probability that the drawing pin will land 'point up' both times.

....................................

**(2)**
**(Total 4 marks)**

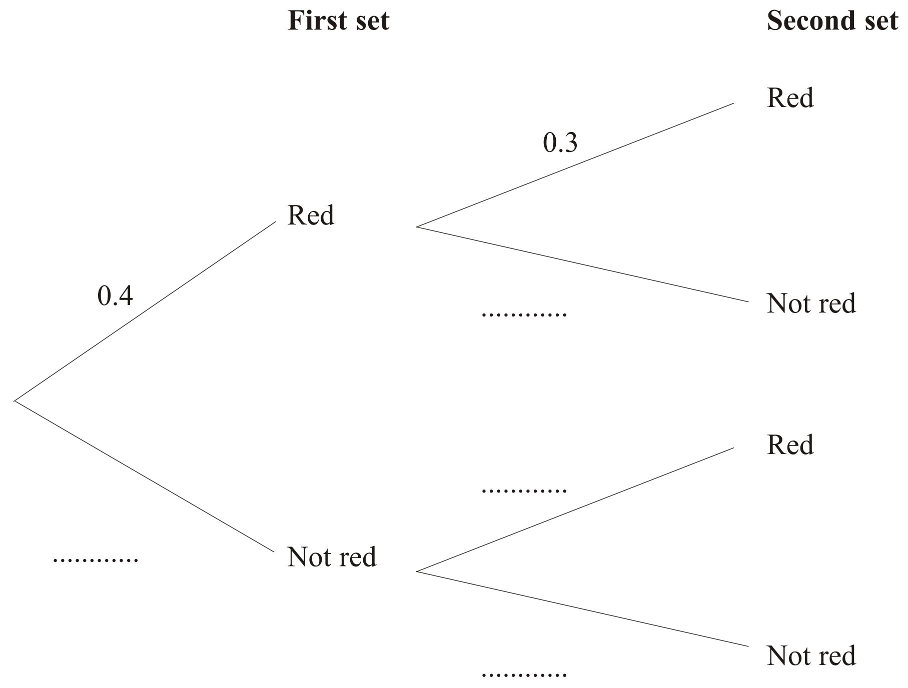
**22.** The probability that any piece of buttered toast will land buttered side down when it is dropped is 0.62
Two pieces of buttered toast are to be dropped, one after the other.

Calculate the probability that exactly one piece of buttered toast will land buttered side down.

.....................................
**(Total 4 marks)**

**23.** There are two sets of traffic lights on Georgina's route to school.
The probability that the first set of traffic lights will be red is 0.4
The probability that the second set of traffic lights will be red is 0.3

(a) Complete the probability tree diagram.




**(2)**

(b) Work out the probability that both sets of traffic lights will be red.

.....................................

**(2)**

(c) Work out the probability that exactly one set of traffic lights will be red.

.....................................

**(3)**
**(Total 7 marks)**

**24.** Martin has a pencil case which contains 4 blue pens and 3 green pens.

Martin picks a pen at random from the pencil case. He notes its colour, and then replaces it.
He does this two more times.

Work out the probability that when Martin takes three pens, exactly two are the same colour.

.................................

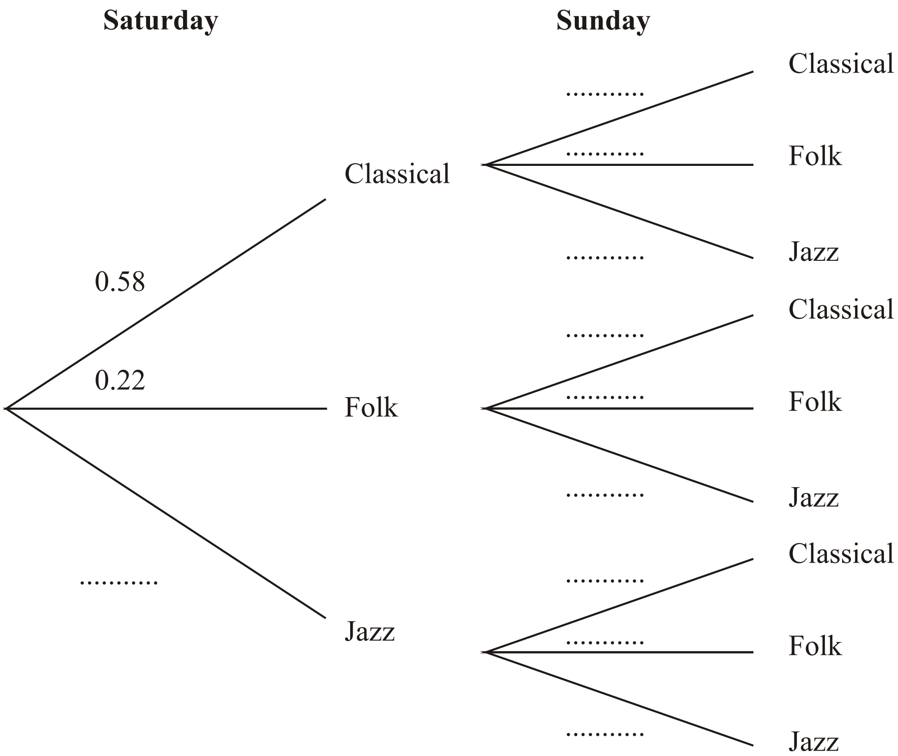
**(Total 3 marks)**

**25.** Julie has 100 music CDs.
58 of the CDs are classical.
22 of the CDs are folk.
The rest of the CDs are jazz.

On Saturday, Julie chooses one CD at random from the 100 CDs.
On Sunday, Julie chooses one CD at random from the 100 CDs.

(a) Complete the probability tree diagram.

**(2)**




(b) Calculate the probability that Julie will choose a jazz CD on **both** Saturday and Sunday.

..................................

**(2)**

(c) Calculate the probability that Julie will choose at least one jazz CD on Saturday and Sunday.

...................................

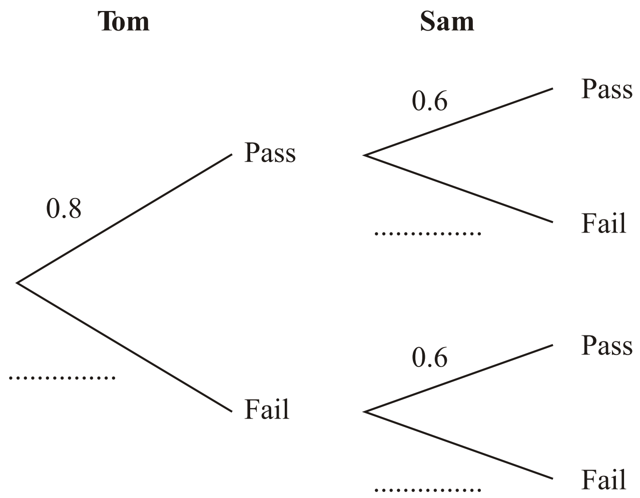
**(3)**
**(Total 7 marks)**

**26.** Tom and Sam each take a driving test.

The probability that Tom will pass the driving test is 0.8

The probability that Sam will pass the driving test is 0.6

(a) Complete the probability tree diagram.




**(2)**

(b) Work out the probability that both Tom and Sam will pass the driving test.

.......................................................

**(2)**

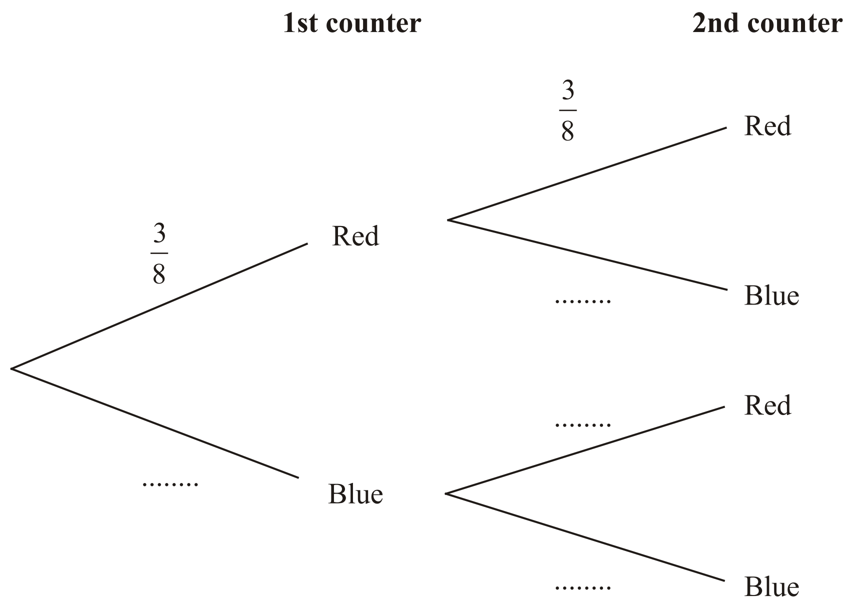
(c) Work out the probability that only one of them will pass the driving test.

..........................................................

**(3)**
**(Total 7 marks)**

**27.** Matthew puts 3 red counters and 5 blue counters in a bag.
He takes at random a counter from the bag.
He writes down the colour of the counter.
He puts the counter in the bag again.
He then takes at random a second counter from the bag.

(a) Complete the probability tree diagram.




**(2)**

(b) Work out the probability that Matthew takes two red counters.

..........................

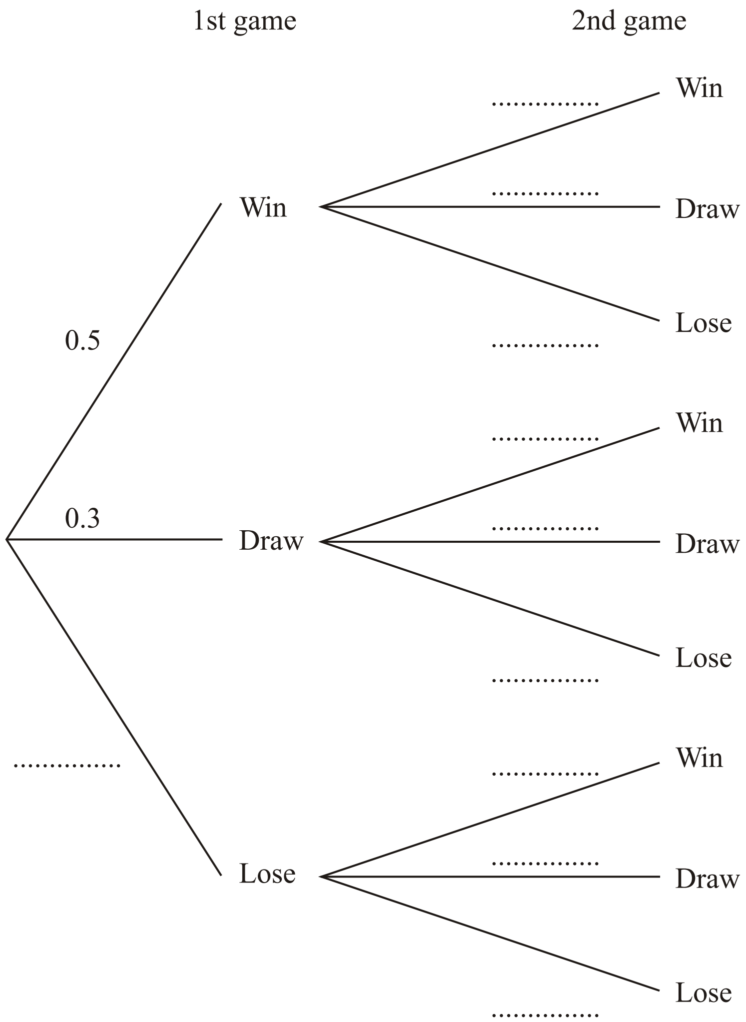
**(2)**
**(Total 4 marks)**

**28.** In a game of chess, a player can either win, draw or lose.

The probability that Vishi wins any game of chess is 0.5
The probability that Vishi draws any game of chess is 0.3

Vishi plays 2 games of chess.

(a) Complete the probability tree diagram.




**(2)**

(b) Work out the probability that Vishi will win both games.

.....................................

**(2)**
**(Total 4 marks)**

**29.** Phil has 20 sweets in a bag.

5 of the sweets are orange.
7 of the sweets are red.
8 of the sweets are yellow.

Phil takes at random **two** sweets from the bag.

Work out the probability that the sweets will **not** be the same colour.

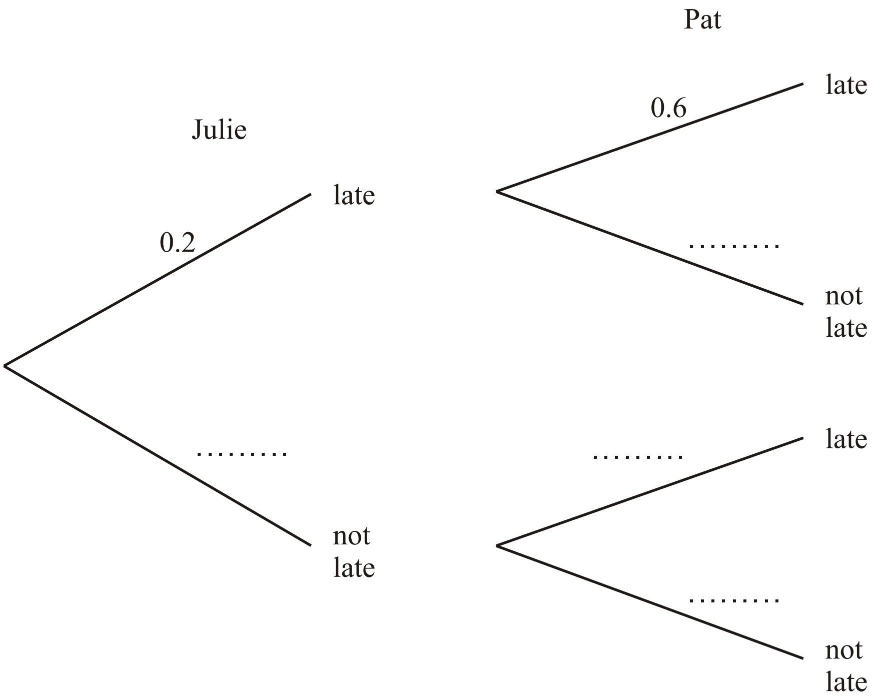
................................................

**(Total 4 marks)**

**30.** Julie and Pat are going to the cinema.

The probability that Julie will arrive late is 0.2
The probability that Pat will arrive late is 0.6
The two events are independent.

(a) Complete the diagram.




**(2)**

(b) Work out the probability that Julie and Pat will both arrive late.

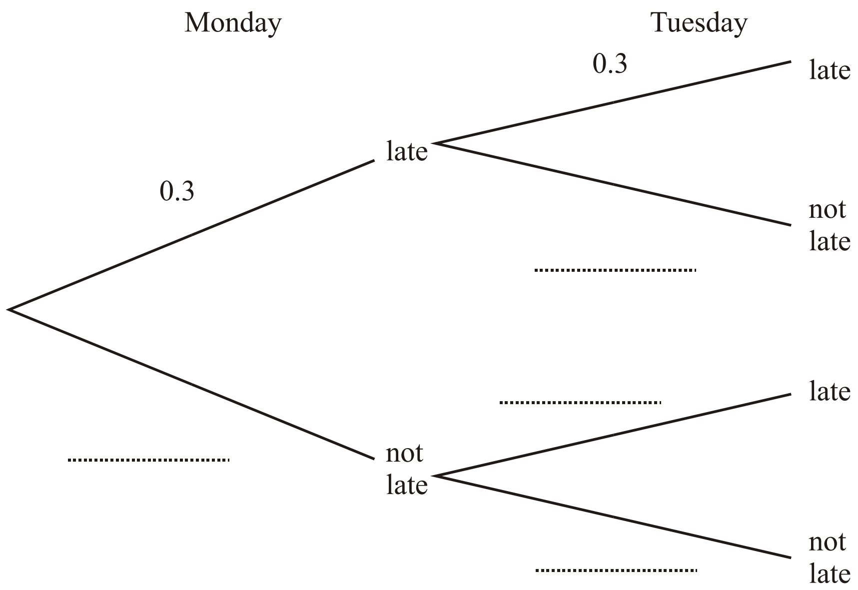
..................................

**(2)**
**(Total 4 marks)**

**31.** Salika travels to school by train every day.

The probability that her train will be late on any day is 0.3

(a) Complete the probability tree diagram for Monday and Tuesday.




**(2)**

(b) Work out the probability that her train will be late on **at least one** of these two days.

..............................

**(3)**

**(Total 5 marks)**

**32.** A bag contains 3 black beads, 5 red beads and 2 green beads.
Gianna takes a bead at random from the bag, records its colour and replaces it.
She does this two more times.

Work out the probability that, of the three beads Gianna takes, exactly two are the same colour.

..............................

**(Total 5 marks)**

**33.** Daniel took a sample of 100 pebbles from Tawny Beach.
He weighed each pebble and recorded its weight.
He used the information to draw the cumulative frequency graph shown on the grid.

(a) Use the cumulative frequency graph to find an estimate for

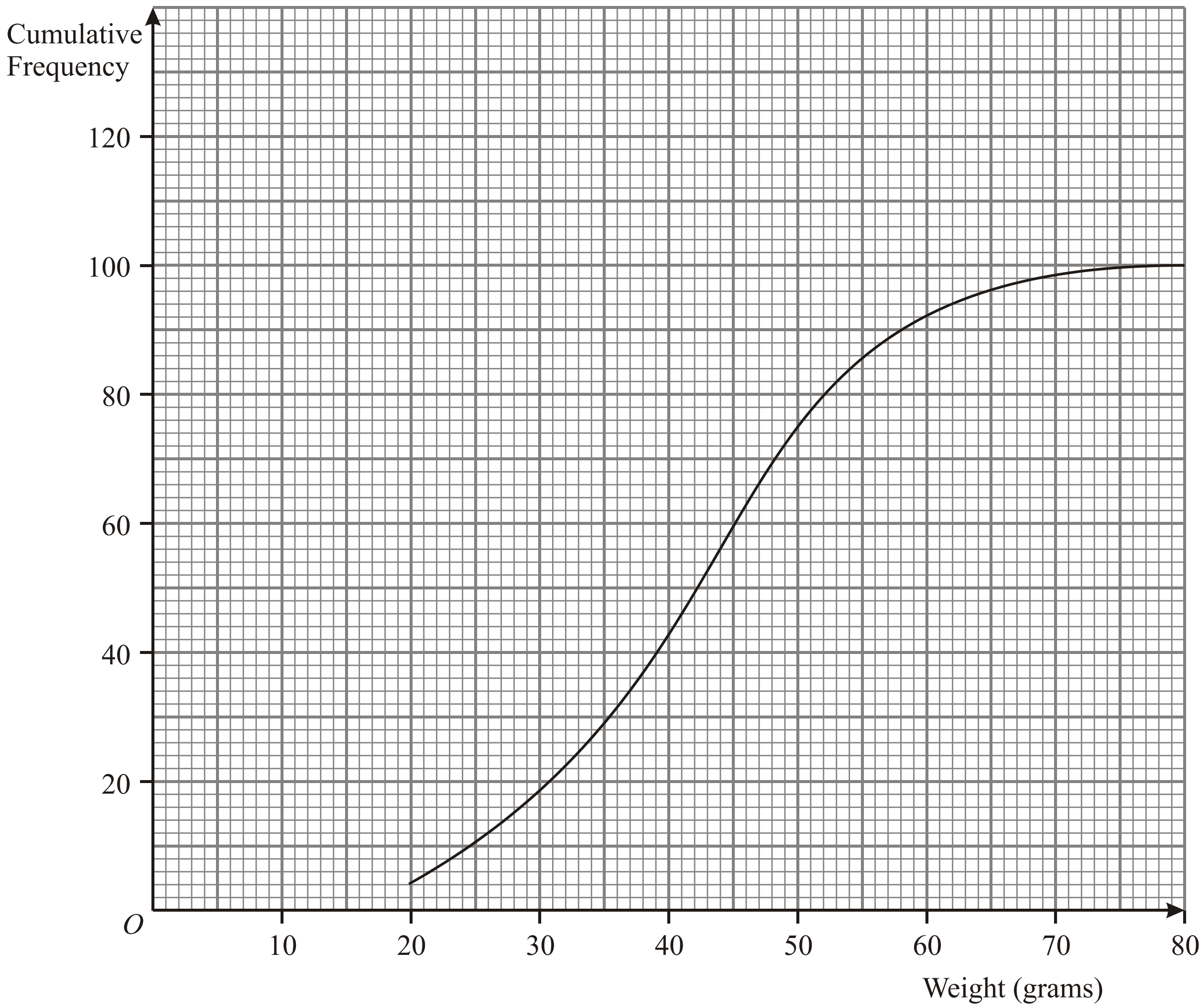
(i) the median weight of these pebbles,

.............................. grams

(ii) the number of pebbles with a weight more than 60 grams.

........................................

**(3)**




Daniel also took a sample of 100 pebbles from Golden Beach.
The table shows the distribution of the weights of the pebbles in the sample from Golden Beach.

| Weight ($w$ grams) | Cumulative frequency |
|---|---|
| $0 < w \le 20$ | 1 |
| $0 < w \le 30$ | 15 |
| $0 < w \le 40$ | 36 |
| $0 < w \le 50$ | 65 |
| $0 < w \le 60$ | 84 |
| $0 < w \le 70$ | 94 |
| $0 < w \le 80$ | 100 |

(b) On the same grid, draw the cumulative frequency graph for the information shown in the table.

**(2)**

Daniel takes one pebble, at random, from his sample from Tawny Beach and one pebble, at random, from his sample from Golden Beach.

(c) Work out the probability that the weight of the pebble from Tawny Beach is more than 60 grams **and** the weight of the pebble from Golden Beach is more than 60 grams.

.....................................

**(4)**

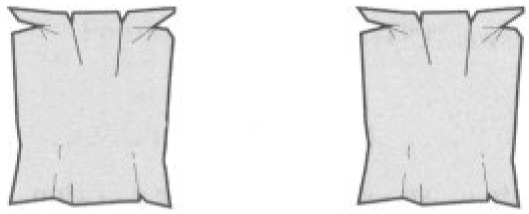
**(Total 9 marks)**

**34.** Jim spins a biased coin.
The probability that it will land on heads is twice the probability that it will land on tails.

Jim spins the coin twice.
Find the probability that it will land once on heads and once on tails.

........................
**(Total 4 marks)**

**35.** Jacob has 2 bags of sweets.

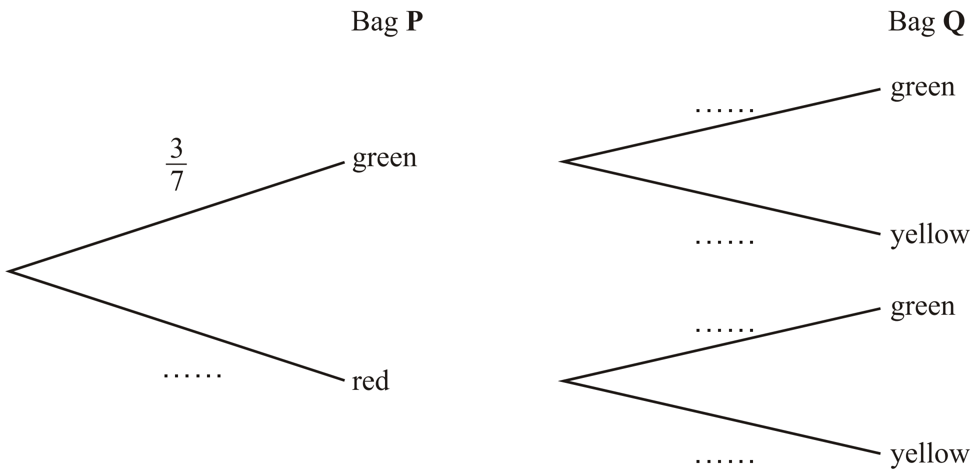


Bag **P** Bag **Q**

Bag **P** contains 3 green sweets and 4 red sweets.
Bag **Q** contains 1 green sweet and 3 yellow sweets.

Jacob takes one sweet at random from each bag.

(a) Complete the tree diagram.




**(2)**

(b) Calculate the probability that Jacob will take 2 green sweets.

…………………

**(2)**
**(Total 4 marks)**

**36.** Tony designs a game.
It costs £1.20 to play the game.

The probability of winning the game is $\frac{3}{10}$

The prize for each win is £2.50
150 people play the game.

Work out an estimate of the profit that Tony should expect to make.

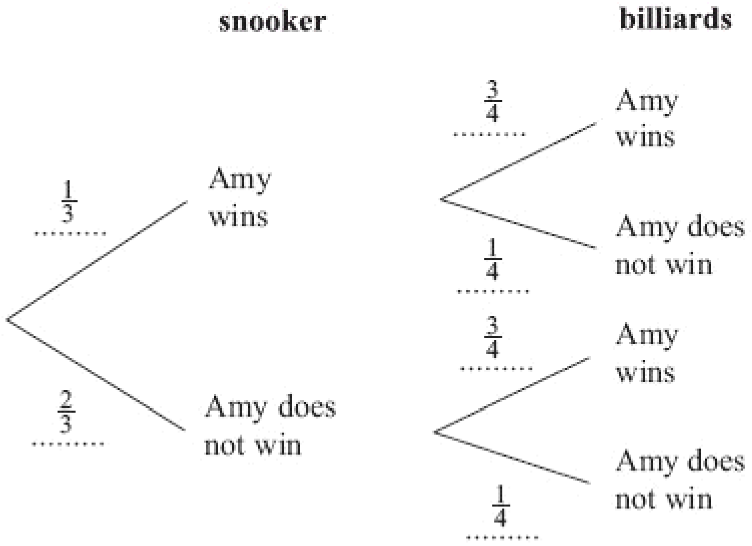
£ ..............................
**(Total 4 marks)**

**37.** Amy is going to play one game of snooker and one game of billiards.

The probability that she will win the game of snooker is $\frac{1}{3}$

The probability that she will win the game of billiards is $\frac{3}{4}$

The probability tree diagram shows this information.




Amy played one game of snooker and one game of billiards on a number of Fridays.
She won at **both** snooker and billiards on 21 Fridays.

Work out an estimate for the number of Fridays on which Amy did not win either game.

…………

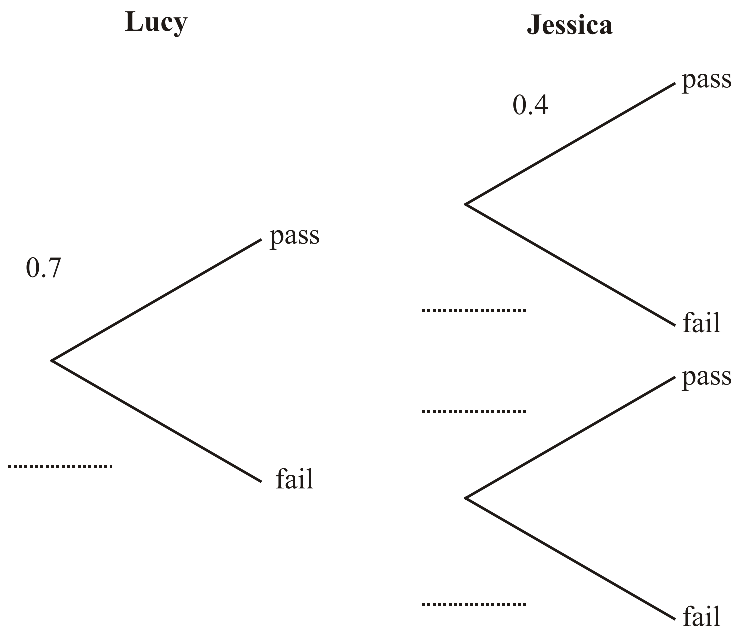
**(Total 3 marks)**

**38.** Lucy and Jessica take a test.

The probability that Lucy will pass the test is 0.7

The probability that Jessica will pass the test is 0.4

(a) Complete the probability tree diagram.




**(2)**

(b) Work out the probability that only one of the 2 girls will pass the test.

..............................

**(3)**
**(Total 5 marks)**

**39.** Stuart is taking a French exam and an art exam.

The probability that Stuart will pass the French exam is 0.7
The probability that Stuart will pass the art exam is 0.8

Work out the probability that Stuart will pass exactly one of these exams.

.....................................
**(Total 3 marks)**

**40.** A spinner can land on Red or White or Blue.
The table shows the probability that the spinner will land on Red or on White.

| Colour | Red | White | Blue |
|---|---|---|---|
| Probability | 0.3 | 0.25 | |

(a) Work out the probability that the spinner will land on Blue.

.....................................
**(2)**

Sam is going to spin the spinner 200 times.

(b) Work out an estimate for the number of times the spinner will land on Red.

.....................................
**(2)**
**(Total 4 marks)**

**41.** There are 9 stones in a bag.
4 stones are blue.
5 stones are green.

Lisa takes a stone at random from the bag.
She **does not replace it.**
She then takes at random a second stone from the bag.

Work out the probability that at least one of these two stones is blue.

.....................................

**(Total 3 marks)**

**42.** Sunita plays a game of chess.
She can win or draw or lose the game.

The table shows each of the probabilities that she will win or draw the game.

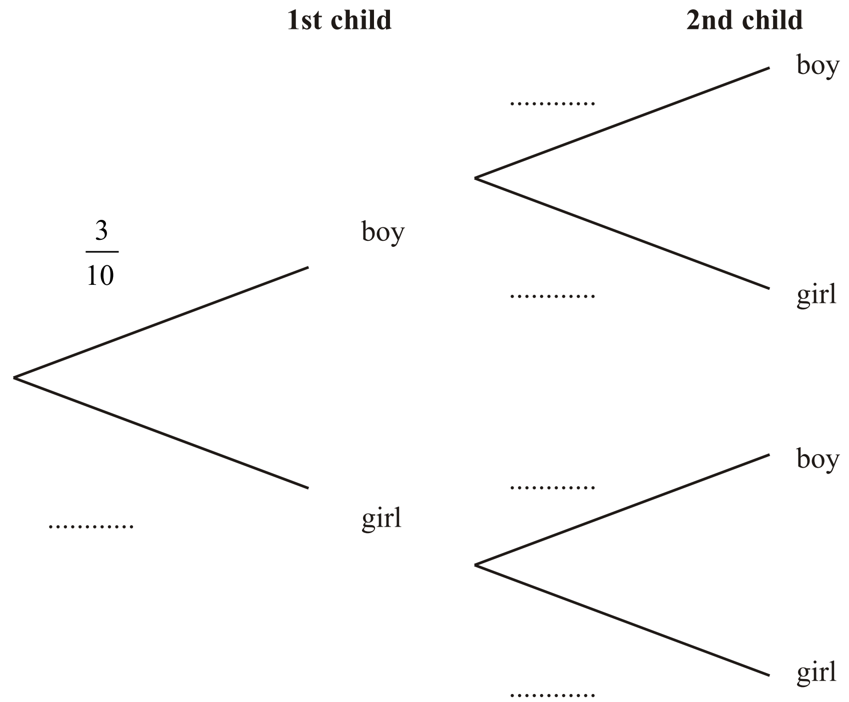
| Result | Win | Draw | Lose |
|---|---|---|---|
| Probability | 0.6 | 0.3 | |

Work out the probability that she will lose the game.

.....................................
**(Total 2 marks)**

**43.** There are 3 boys and 7 girls at a playgroup.
Mrs Gold selects two children at random.

(a) Complete the probability tree diagram below.




**(2)**

(b) Work out the probability that Mrs Gold selects two girls.

.....................................

**(2)**
**(Total 4 marks)**

**44.** Caroline cycles to school.
She passes through two sets of traffic lights.

The probability that she has to stop at the first set of traffic lights is $\frac{2}{5}$

If she has to stop at the first set of traffic lights, the probability that she has to stop at the second set is $\frac{5}{6}$

If she does **not** have to stop at the first set of traffic lights, the probability that she has to stop at the second set is $\frac{1}{2}$

Caroline cycles to school on the last day of term.

Work out the probability that she has to stop at only **one** set of traffic lights.

.....................................

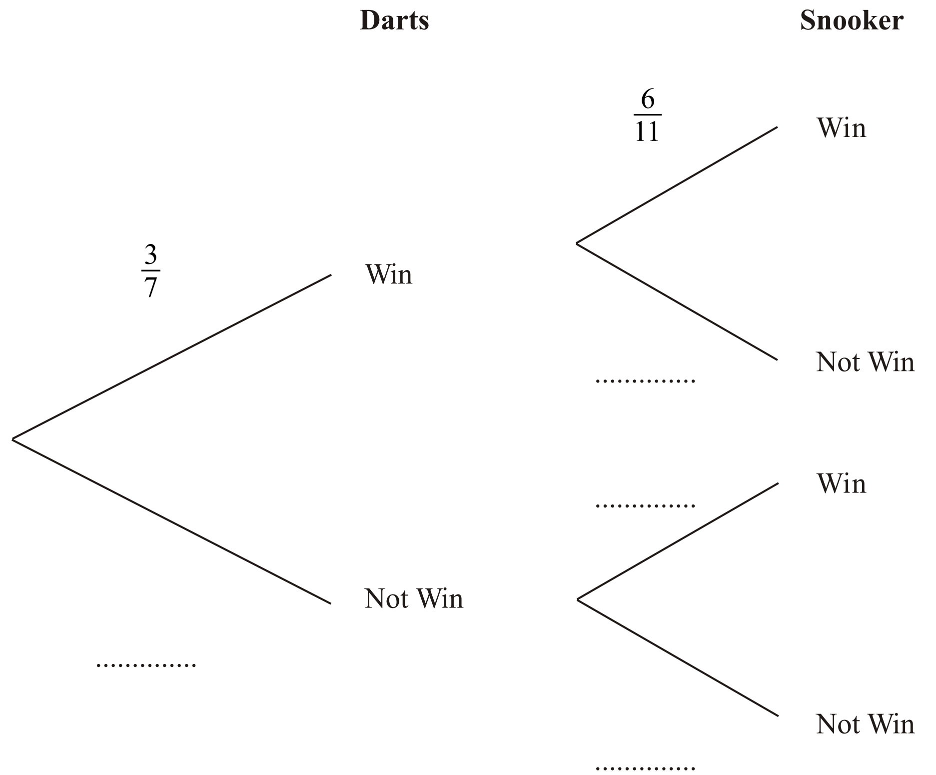
**(Total 4 marks)**

**45.** Ivan plays a game of darts and a game of snooker.

The probability that he will win at darts is $\frac{3}{7}$

The probability that he will win at snooker is $\frac{6}{11}$

Complete the probability tree diagram.




**(Total 2 marks)**

**46.** There are 3 strawberry yoghurts, 2 peach yoghurts and 4 cherry yoghurts in a fridge.

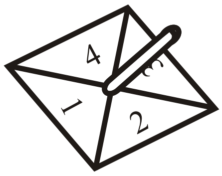
Kate takes a yoghurt at random from the fridge.
She eats the yoghurt.
She then takes a second yoghurt at random from the fridge.

Work out the probability that both the yoghurts were the same flavour.

.....................................

**(Total 4 marks)**

**47.** Marco has a 4-sided spinner.
The sides of the spinner are numbered 1, 2, 3 and 4
The spinner is biased.




The table shows the probability that the spinner will land on each of the numbers 1, 2 and 3

| Number | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Probability | 0.20 | 0.35 | 0.20 | |

(a) Work out the probability that the spinner will land on the number 4

..................................
**(2)**

Marco spins the spinner 100 times.

(b) Work out an estimate for the number of times the spinner will land on the number 2

.....................................

**(2)**

**(Total 4 marks)**

**48.** There are 8 pencils in a box.

5 pencils are blue.
3 pencils are red.

Simon takes a pencil at random from the box.
He does not replace the pencil.
Hazel then takes a pencil at random from the box.

Work out the probability that both Simon and Hazel take a red pencil.

.....................................

**(Total 3 marks)**

**49.** Sue wants to find out if a 6-sided dice is biased.
She rolls the dice six times.

The table shows her results.

| **Score** | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| **Frequency** | 0 | 1 | 1 | 1 | 1 | 2 |

Sue says

"My experiment shows this dice is biased".

Sue is wrong.
Explain why.

.....................................................................................................................................

.....................................................................................................................................

.....................................................................................................................................

**(Total 1 mark)**

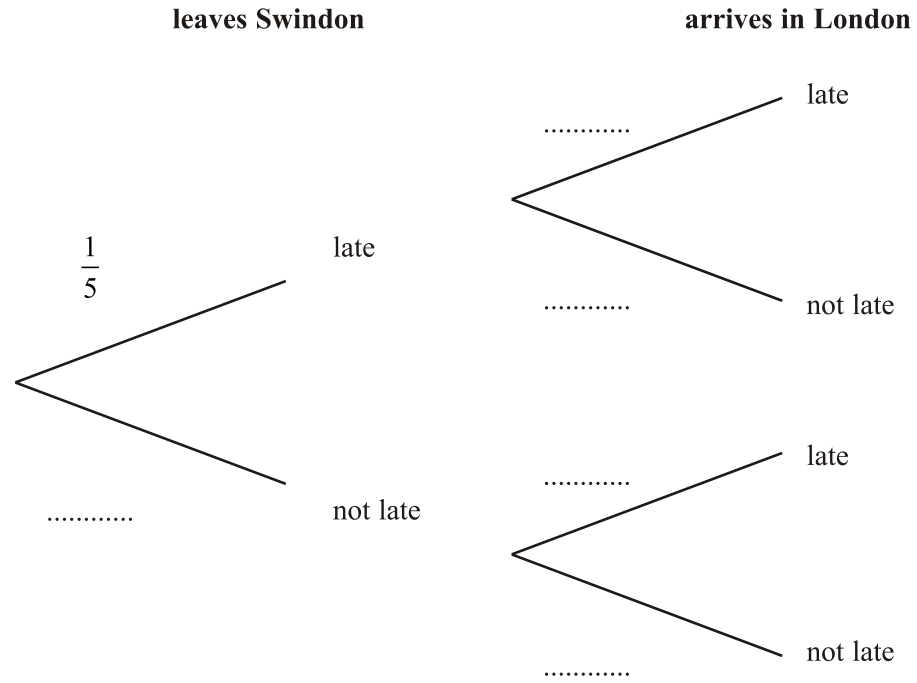
**50.** Nicola is going to travel from Swindon to London by train.

The probability that the train will be late leaving Swindon is $\frac{1}{5}$

If the train is late leaving Swindon, the probability that it will arrive late in London is $\frac{7}{10}$

If the train is **not** late leaving Swindon, the probability that it will arrive late in London is $\frac{1}{10}$

(a) Complete the probability tree diagram.




**(2)**

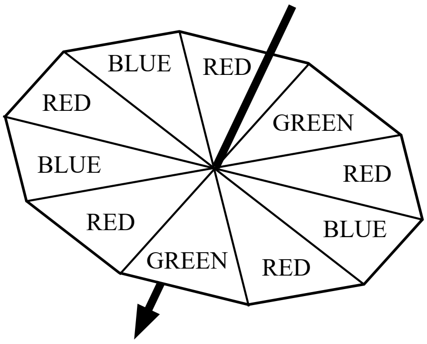
(b) Work out the probability that Nicola will arrive late in London.

..........................

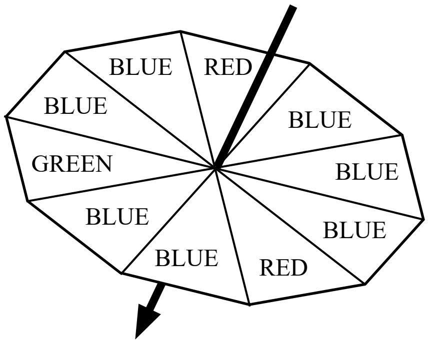
**(3)**

**(Total 5 marks)**

**51.** William has two 10-sided spinners.
The spinners are equally likely to land on each of their sides.




**A**




**B**

Spinner **A** has 5 red sides, 3 blue sides and 2 green sides.
Spinner **B** has 2 red sides, 7 blue sides and 1 green side.

William spins spinner **A** once.
He then spins spinner **B** once.

Work out the probability that spinner **A** and spinner **B** do **not** land on the same colour.

..........................
**(Total 4 marks)**

**52.** There are 4 bottles of orange juice,
3 bottles of apple juice,
2 bottles of tomato juice.

Viv takes a bottle at random and drinks the juice.
Then Caroline takes a bottle at random and drinks the juice.

Work out the probability that they both take a bottle of the same type of juice.

....................................

**(Total 4 marks)**

**01.** (a) No, as you would expect about 100.
Yes, as it is possible to get 200 sixes with a fair dice 1

*B1 for a consistent answer*

(b) 3

$\frac{1}{6}, \frac{5}{6}$ + labels

*B1 for* $\frac{5}{6}$ *on the red dice, <u>not six</u> branch*

*B1 for a fully complete tree diagram with all branches labelled*

*B1 for* $\frac{1}{6}$, $\frac{5}{6}$ *on all remaining branches as appropriate*

**[4]**

**02.** $\frac{660}{1000}$ oe 5

Total = 3 + 5 + 2 (= 10)

$\frac{3}{10}\times\frac{3}{10}\times\frac{5}{10}\left(=\frac{45}{1000}\right), \frac{3}{10}\times\frac{3}{10}\times\frac{2}{10}\left(=\frac{18}{1000}\right)$

$\frac{5}{10}\times\frac{5}{10}\times\frac{3}{10}\left(=\frac{75}{1000}\right), \frac{5}{10}\times\frac{5}{10}\times\frac{2}{10}\left(=\frac{50}{1000}\right)$

$\frac{2}{10}\times\frac{2}{10}\times\frac{3}{10}\left(=\frac{12}{1000}\right), \frac{2}{10}\times\frac{2}{10}\times\frac{5}{10}\left(=\frac{20}{1000}\right)$

$3\times\left(\frac{"45"}{1000}+\frac{"18"}{1000}+\frac{"75"}{1000}+\frac{"50"}{1000}+\frac{"12"}{1000}+\frac{"20"}{1000}\right)$

$\frac{660}{1000}$

*M3 for all six expressions seen OR their combined equivalents*
*(M2 for four expressions seen OR their combined equivalents)*
*(M1 for two expressions seen OR their combined equivalents)*
*M1 sum of 18 relevant products condone 1 slip*
*A1 for* $\frac{660}{1000}$ *oe*
SC: without replacement maximum M4 A0
*SC: Just 2 beads: Answer either* $\frac{38}{100}$ *oe OR* $\frac{28}{90}$ *oe B1*

**[5]**

**03.** (a) No, as you would expect about 100.
Yes, as it is possible to get 200 sixes with a fair dice 1
*B1 for a consistent answer*

(b) 3

$\frac{1}{6}, \frac{5}{6}$ + labels

*B1 for* $\frac{5}{6}$ *on the red dice, not six branch*
*B1 for a fully complete tree diagram with all branches labelled*
*B1 for* $\frac{1}{6}$ *and* $\frac{5}{6}$ *on all remaining branches as appropriate*

(c) (i) $\frac{1}{36}$ 2

$\left(\frac{1}{6}\right)^2$

*M1* $\left(\frac{1}{6}\right)^2$ *or* $\frac{1}{6}\times\frac{1}{6}$ *only or 0.28*

*A1* $\frac{1}{36}$ *or 0.03 or better*

(ii) $\frac{11}{36}$ 3

$1-\left(\frac{5}{6}\right)^2$

OR

$\frac{1}{6}\times\frac{5}{6}+\frac{5}{6}\times\frac{1}{6}+\frac{1}{6}\times\frac{1}{6}$

*M2 for* $1-\left(\frac{5}{6}\right)^2$ *or* $1-\frac{5}{6}\times\frac{5}{6}$

*A1 cao*

*OR*

*M1 for* $\frac{1}{6}\times\frac{5}{6}$ *oe*

*M1 for 2 or 3 only of* $\frac{1}{6}\times\frac{5}{6},\frac{5}{6}\times\frac{1}{6},$ *"a"*

*A1 for* $\frac{11}{36}$ *or 0.31 or better*

**[9]**

**04.** No 2

$0.06 \times 0.05 = 0.003$

*M1 for* $0.06 \times 0.05$

*A1 correct conclusion based on 0.003 or 0.06 × 0.05 stated as* $\neq 0.0011$

*OR M1 for statement that for the two events to be independent P (BL and CL) = P(BL)* $\times$ *P(CL)*

**[2]**

**05.** (a) 8 3

$\frac{50}{500} \times 76$

*M1 for* $\frac{50}{500} \times 76$ *oe*
*A2 cao*
*(A1 for 7.6)*

(b) 86 2

9 × 10 or 90 or 8.5 × 10

*M1 for 9 × 10 or 90 or 8.5 × 10 or 8.6 × 10 seen*
*A1 for either 86 or for 85*

(c) $\frac{3}{20}$ 3

$\frac{30}{80}$ $\frac{40}{100}$

$\frac{3}{8} \times \frac{2}{5}$

*B1 for* $\frac{30}{80}$ *or* $\frac{40}{100}$ *oe seen*
*M1 for multiplying only two probabilities or full relevant complete method*
*A1* $\frac{3}{20}$ *oe*

**[8]**

**06.** $\frac{119}{180}$ 4

$\frac{6}{15}\times\frac{3}{12}+\frac{6}{15}\times\frac{5}{12}=\frac{48}{180}$

$\frac{4}{15}\times\frac{4}{12}+\frac{4}{15}\times\frac{5}{12}=\frac{36}{180}$

$\frac{5}{15}\times\frac{4}{12}+\frac{5}{15}\times\frac{3}{12}=\frac{35}{180}$

***Or***

$1-\left[\frac{6}{15}\times\frac{4}{12}+\frac{4}{15}\times\frac{3}{12}+\frac{5}{15}\times\frac{5}{12}\right]$

$=1-\frac{61}{180}$

*M1 for sight of any 2 correct uses of the 6 cases*
*M1 for sight of remaining 4 correct uses of the 6 cases*
*M1 (dep on at least 3 correct terms) for adding 5 or 6 correct terms*
*A1 cao*
*M1 for use of complimentary event*
*M1 for sight of any 2 correct terms*
*M1 for* $1-\left[\frac{6}{15}\times\frac{4}{12}+\frac{4}{15}\times\frac{3}{12}+\frac{5}{15}\times\frac{5}{12}\right]$
*A1 cao*

**[4]**

**07.** (a) 0.4, 0.6
0.4, 0.6,
0.4 2

*B1 for LHS: (0.6), 0.4*
*B1 for RHS: 0.6, 0.4, 0.6, 0.4*

(b) 38 3

(30 × 42) – (25 × 42.8) = 1260 – 1070 = 190
190 ÷ 5 =

*M1 for (30 × 42) – (25 × 42.8) or 1260 – 1070 or 190 seen*
*M1 (dep) for "190" ÷ 5*
*A1 cao*

**[5]**

**08.** 0.6 2

0.2 + 0.4

*M1 for 0.2 + 0.4*
*A1 for 0.6*

**[2]**

**09.** (a) (i) $(2x-7)(x-14)$ 3

*M1 $x^2$ term and constant term ($\pm 98$ obtained*
*or $2x(x-14) - 7(x-14)$ or $x(2x-7) - 14(2x-7)$*
*A1 for $(2x-7)(x-14)$*

(ii) $x = \frac{7}{2}$; $x = 14$

*B1ft ft (i) provided of form $(2x \pm a)(x \pm b)$*

(b) (i) $\frac{7}{n+7}$ 3

*B1 for $\frac{7}{n+7}$ oe*

(ii) $n$=10.5 is not possible since $n$ has to be an integer

$\frac{7}{n+7} = \frac{2}{5} \Rightarrow 2(n+7) = 5 \times 7$

$2n = 21$

*M1 for $2(n+7) = 5 \times 7$ or $n+7 = 5 \times 3.5$ (can be implied) ft (b)(i) fractional in terms of n and < 1*
*A1 ft for n = 10.5 not possible (since n not integer) oe*

(c) $2n^2 - 35n + 98 = 0$ 5

$$2 \times \left(\frac{n}{n+7}\right) \times \left(\frac{7}{n+7}\right) = \frac{4}{9}$$

$14n \times 9 = 4(n+7)^2$

$14n \times 9 = 4(n^2 + 14n + 49)$

$4n^2 + 56n + 196 - 126n = 0$

*M1 for $\left(\frac{n}{n+7}\right) \times \left(\frac{7}{n+7}\right)$ seen*

*M1 for $2 \times \left(\frac{n}{n+7}\right) \times \left(\frac{7}{n+7}\right)$ oe $= \left(\frac{4}{9}\right)$*

*M1(dep on 1st M) elimination of fractions within an equation*

*B1 3 terms correct in expansion of $(n+7)^2 = n^2 + 7n + 7n + 49$*

*A1 full valid completion to printed answer*

(d) $\frac{1}{9}$ 2

$\frac{7}{n+7} \times \frac{7}{n+7} = \frac{7}{21} \times \frac{7}{21} =$

*M1 for* $\frac{7}{n+7} \times \frac{7}{n+7}$ *or better or ft [answer (b)(i)]*$^2$

*or* $1 - \frac{4}{9} - \left(\frac{n}{n+7}\right)^2$

*A1 for* $\frac{1}{9}$ *oe cao*

**[13]**

**10.** (a) 0.4
0.6,0.4,
0.6,0.4 2

*B1 for LHS: (0.6), 0.4*
*B1 for RHS: 0.6, 0.4, 0.6, 0.4*

(b) 0.36 2

0.6 × 0.6

*M1 0.6 × "0.6" [0 < "0.6" < 1]*
*A1 cao*

(c) 38 3

(30 × 42) – (25 × 42.8) = 1260 – 1070 = 190
190 ÷ 5 =

*M1 for (30 × 42) – (25 × 42.8) or 1260 – 1070 or 190 seen*
*M1(dep) for "190" ÷ 5*
*A1 cao 38*

**[7]**

**11.** (a) $\frac{30}{100}$ 1

*B1 cao*

(b) 175 2

$250 \times 0.7$

*M1 for 250 × 0.7*
*A1 cao*
*NB $\frac{175}{250}$ gets M1 A0, 175 out of 250 gets M1 A1*

**[3]**

**12.** (a) 0.495 3

$0.55 \times 0.45 \times 2$

*M1 for 0.55 × 0.45 or 0.55 × 0.3 or 0.55 × 0.15 seen*
*M1 (dep) for 0.55 × 0.45 × 2 or adding 3 or 4 correct terms out of 0.55 × 0.3 × 2 +0.55 × 0.15 ×2*
*A1 cao*

(b) 0.255 3

WL or LW or DD
$0.55 \times 0.15$, $0.15 \times 0.55$, $0.3 \times 0.3$
$0.165 + 0.09$

*M1 for 0.55 × 0.15 or 0.3 × 0.3*
*M1(dep) for adding 2 or 3 correct terms*
*A1cao*

**[6]**

**13.** $\frac{1}{4}$ on LH branch

$\frac{2}{3}$ & $\frac{1}{3}$ & $\frac{2}{3}$ on RH branches 2

*B1*
*B1*

**[2]**

**14.** (a) $\frac{1}{4}$ on LH branch

$\frac{2}{3}$ & $\frac{1}{3}$ & $\frac{2}{3}$ on RH branches 2

*B1 cao*
*B1*

(b) $\frac{7}{12}$ 3

$\frac{3}{4}\times\frac{2}{3}+\frac{1}{4}\times\frac{1}{3} = \frac{6}{12}+\frac{1}{12}$

*M1 for* $\frac{3}{4} \times \frac{2}{3}$ *or* $\frac{1}{4} \times \frac{1}{3}$ *from their tree diagram*
*M1 for sum of two products*
*A1 for* $\frac{7}{12}$ *oe*

(c) 14 3

$n = 21 \times 4$ or $\frac{1}{6}:\frac{1}{4}$ oe

$\frac{1}{6} \times 84$ or $21 \times \frac{2}{3}$

*M1 for either* $\frac{1}{3} \times \frac{3}{4} \left(=\frac{1}{4}\right)$ *or* $\frac{2}{3} \times \frac{1}{4} \left(=\frac{1}{6}\right)$ *from their tree diagram*

*M1 for 21 × 4 (= 84) or* $\frac{21}{3} \times 2$

*A1 for 14 cao*
*SC: B2 for 63 seen in fraction or ratio*

**[8]**

**15.** (a) $\frac{8}{25}$ 3

P(win) = $\frac{2}{5}\times\frac{3}{5}+\frac{2}{5}\times\frac{1}{5}(=\frac{8}{25})$

*M1 for $\frac{2}{5}\times\frac{3}{5}$ or $\frac{2}{5}\times\frac{1}{5}$ or for clearly identifying in P(R) × P(R) + P(B) × P(B)*

*M1 for P(win) = $"\frac{2}{5}"\times"\frac{3}{5}"+"\frac{2}{5}"\times"\frac{1}{5}"$*

*A1 for $\frac{8}{25}$, oe*

(b) £4 2

$\frac{8}{25}\times 100$ (= 32)

100 × 20 – "32" × 50

*M1 for ( $"\frac{8}{25}"\times 100$) × 50 or × 0.5*

*A1 cao*

**[5]**

**16.** $\frac{2}{5},\frac{5}{7},\frac{2}{7},\frac{5}{7}$ 2

*B1 for $\frac{2}{5}$ in the correct place*

*B1 for $\frac{5}{7},\frac{2}{7},\frac{5}{7}$ all in the correct place*

**[2]**

**17.** (a) $\frac{2}{5},\frac{5}{7},\frac{2}{7},\frac{5}{7}$ 2

*B1 for $\frac{2}{5}$ in the correct place*

*B1 for $\frac{5}{7},\frac{2}{7},\frac{5}{7}$ all in the correct places*

(b) $\frac{3}{5}\times\frac{5}{7}+\frac{2}{5}\times\frac{2}{7}$

$\frac{19}{35}$ 3

*M1 for* $\left(\frac{3}{5}\times\frac{5}{7}\right)$ ***or*** $\left(\frac{2}{5}\times\frac{2}{7}\right)$

*M1 (dep) for* $\left(\frac{3}{5}\times\frac{5}{7}\right) + \left(\frac{2}{5}\times\frac{2}{7}\right)$

*A1 cao*

**[5]**

**18.** (a) $(19x + 28)(x - 8)$

$x = 8$

$x = -28/19$ 3

*M1 for either (ax + b) (cx + d) with ac = 19 and bd = ±224*

*or for a clear attempt to use* $\frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ *with a = 19,*

*b = ±124, c = ±224*

*A1 for either (19x + 28)(x – 8) or for* $x = \frac{124 \pm \sqrt{32400}}{38}$

*A1 for 8 <u>and</u> –28/19 oe (accept –1.47 or better)*

(b) red = $n$ blue = $n + 2$ white = $n + (n + 2)$

$n + (n + 2) + [n + (n + 2)] = 4n + 4 = 4(n + 1)$*

Proof 1

*B1 for n + (n +2) + [n +(n +2)]*

(c) $\left(\frac{n}{4(n+1)}\right) \times \left(1 - \frac{n}{4(n+1)}\right) = \frac{14}{81}$

$\left(\frac{n}{4(n+1)}\right) \times \left(\frac{3n+4}{4(n+1)}\right) = \frac{14}{81}$

$81n(3n + 4) = 14 \times 16(n + 1)^2$

$243n^2 + 324n = 224(n^2 + 2n + 1)$

$243n^2 + 324n = 224n^2 + 448n + 224$

$\Rightarrow 19n^2 - 124n - 224 = 0$*

Proof 5

*M1 for multiplying two fractions*

*A1for* $\left(\frac{n}{4(n+1)}\right) \times \left(1 - \frac{n}{4(n+1)}\right)$ *oe*

*B1 for correct expansion of* $(n + 1)^2$

*M1 for a valid method to eliminate fractions from an algebraic expression*

*A1 complete proof*

(d) from (a) $n = 8$ so $4(n + 1) = 36$

Proof 1

*B1 for substituting n = '8' into 4(n + 1) or 8, 10, 18 seen*

(e) P(different colours) = 1 – [P(RR)+P(BB)+P(WW)]

$$\left[\frac{8}{36}\times\frac{8}{36}+\frac{10}{36}\times\frac{10}{36}+\frac{18}{36}\times\frac{18}{36}\right]$$

OR

P(different colours) = 2 × [P(RB)+P(RW)+P(BW)]

$$=2\times\left[\frac{8}{36}\times\frac{10}{36}+\frac{8}{36}\times\frac{18}{36}+\frac{10}{36}\times\frac{18}{36}\right]$$

OR

P(different colours) =P(RR')+P(BB')+P(WW')

$$=\left[\frac{8}{36}\times\frac{28}{36}+\frac{10}{36}\times\frac{26}{36}+\frac{18}{36}\times\frac{18}{36}\right]$$

$\frac{101}{162}$ 3

*M1 for [P(RR)+P(WW)+P(BB)]*
*or [P(RB)+P(RW)+P(BW)]*
*or [P(RR')+P(BB')+P(WW')]*
*Allow algebraic fractions*

*M1 (dep) for 1 –[P(RR)+P(WW)+P(BB)]*
*or 2×[P(RB)+P(RW)+P(BW)]*
*or P(R)×[1–P(R)]+P(B)×[1–P(B)]+P(W)×[1–P(W)]*
*Numerical values required*

*A1 cao for* $\frac{101}{162}$ *oe or 0.62(3...)*

***SC*** *B2 for* $\frac{202}{315}$ *oe or 0.65(1...)*

**[13]**

**19.** $\frac{1}{4}$

$\frac{2}{3}$ $\frac{1}{3}$ $\frac{2}{3}$ 2

*B1 for* $\frac{1}{4}$ *correct on tennis*

*B1 for* $\frac{2}{3}, \frac{1}{3}, \frac{2}{3}$ *correct on snooker*

**[2]**

**20.** (a) $\frac{1}{4}$

$\frac{2}{3}$ $\frac{1}{3}$ $\frac{2}{3}$ 2

*B1 for $\frac{1}{4}$ correct on tennis*

*B1 for $\frac{2}{3}, \frac{1}{3}, \frac{2}{3}$ correct on snooker*

(b) $\frac{3}{4} \times \frac{1}{3}$

$\frac{1}{4}$ 2

*M1 for $\frac{3}{4} \times \frac{1}{3}$*

*A1 for $\frac{1}{4}$ oe*

(c) $\frac{3}{4} \times \frac{2}{3} + \frac{1}{4} \times \frac{1}{3}$

$\frac{1}{2} + \frac{1}{12}$

$\frac{7}{12}$ 3

*M1 for $\frac{3}{4} \times "\left(\frac{2}{3}\right)"$ **or** $"\left(\frac{1}{4}\right)" \times "\left(\frac{1}{3}\right)"$*

*M1 $\frac{3}{4} \times "\left(\frac{2}{3}\right)" + "\left(\frac{1}{4}\right)" \times "\left(\frac{1}{3}\right)"$*

*A1 for $\frac{7}{12}$ oe (0.58...)*

*Or*

*M2 for $1 - \left(\frac{3}{4} \times \frac{1}{3} + \frac{1}{4} \times \frac{2}{3}\right)$*

*A1 for $\frac{7}{12}$ oe (0.58...)*

**[7]**

**21.** (a) 0.6 — 2

0.6, 0.4, 0.6

*B1 for LHS: (0.4), 0.6*

*B1 for RHS: (0.4), 0.6, 0.4, 0.6*

(b) $0.4 \times 0.4 = 0.16$ — 2

*M1 for* $0.4 \times 0.4$ *or* $\frac{4}{10} \times \frac{4}{10}$ *oe*

*A1 for* $0.16$ *or* $\frac{4}{25}$ *or* $\frac{16}{100}$ *oe*

**[4]**

**22.** $0.62 \times 0.38$ or 0.2356 — 4

$\times 2$ oe

= 0.4712

*B1 for 0.38 seen*

*M1 for* $0.62 \times (1 - 0.62)$ *or 0.2356*

*M1 (dep) for* $\times 2$ *oe*

*A1 for 0.47, 0.471, 0.4712 oe*

**[4]**

**23.** (a) 0.6 and 0.7, 0.3, 0.7 — 2

*B1 for 0.6 on LH branch*

*B1 for 0.7, 0.3 and 0.7 on RH branches*

(b) $0.4 \times 0.3 = 0.12$ — 2

*M1 for* $0.4 \times 0.3$

*A1 0.12 oe*

(c) $0.4 \times 0.7 + 0.6 \times 0.3 = 0.46$ — 3

*M1 for '*$0.4 \times 0.7$*' or '*$0.6 \times 0.3$*'*

*M1 for addition of two products from correct branches*

*A1 0.46 oe*

*Alternative*

*M2 for an attempt to evaluate* $1 - (0.3 \times 0.4 + '0.6 \times 0.7')$

*A1 cao*

**[7]**

**24.** $\frac{4}{7} \times \frac{4}{7} \times \frac{3}{7} + \frac{3}{7} \times \frac{3}{7} \times \frac{4}{7}$

$= \frac{48+36}{343} = \frac{84}{343}$

But there are three ways this can be achieved:
BBG, BGB, GBB

So the probability is $\frac{84}{343} \times 3$

or $1 - \frac{64}{343} - \frac{27}{343}$

NB: 84/343 = 0.244897; 252/343 = 0.73469

$\frac{4}{7}$ = 0.57(142...), $\frac{3}{7}$ = 0.42(857...)

$= \frac{252}{343}$ 3

*M1 for* $\frac{4}{7} \times \frac{4}{7} \times \frac{3}{7}$ *or* $\frac{3}{7} \times \frac{3}{7} \times \frac{4}{7}$ *oe or* $\left(\frac{4}{7}\right)^3$ *oe or* $\left(\frac{3}{7}\right)^3$ *oe*

*or* $\frac{91}{343}$ *or 0.10(49...) or 0.13(99....)*

*M1 (indep) for identification of all 6 outcomes*

*(M2 for* $1 - \left[\left(\frac{4}{7}\right)^3 + \left(\frac{3}{7}\right)^3\right]$*) oe*

*A1* $\frac{252}{343}$, $\frac{36}{49}$, *0.73(469...) oe*

**[3]**

**25.** (a) 0.2
0.58, 0.22 0.2 2

*B1 0.2 on jazz on 1st set*

*B1 0.58, 0.22 0.2*

*repeated 3 times*

(b) 0.2 × 0.2 = 0.04 2

*M1 ‘0.2’ × ‘0.2’*

*A1 cao*

(c) $0.8 \times 0.2 \times 2 + 0.2 \times 0.2$

or

$1 - 0.8 \times 0.8 = 0.36$ 3

*M1 (0.58+0.22) × '0.2'*
*M1 (0.58 + 0.22) × '0.2' × 2 + '0.2' × '0.2'*
*A1 0. 36 cao*
*or*
*M2 1 – $(0.58 + 0.22)^2$*
*A1 0.36 cao*
*Listing the outcomes for (c)*
*CJ 0.58 × '0.2' = 0. 116* *FJ 0.22 × '0.2' = 0.044*
*JC '0.2'× 0.58 = 0.116* *JF '0.2' × 0.22 = 0.044*
*JJ '0.2' × '0.2' = 0.04*
*M2 for all 5 terms added*
*(M1 for any 2, 3 or 4 terms added)*

**[7]**

**26.** (a) 0.2 and 0.4, 0.4 2

*B1 for 0.2 oe on LH branch*
*B1 for 0.4 oe on both RH branches*

(b) $0.8 \times 0.6$
0.48 2

*M1 for 0.8 × 0.6 oe*
*A1 for 0.48 oe*

(c) $0.8 \times 0.4 + 0.2 \times 0.6$
0.44 3

*M1 for 0.8 × '0.4' or '0.2' × 0.6 oe*
*M1 for 0.8 × '0.4' + '0.2' × 0.6 oe*
*A1 for 0.44 oe*
*OR*
*M1 for '0.2' × '0.4' oe*
*M1 for 1 – ('0.8 × 0.6' + '0.2' × '0.4') oe*
*A1 for 0.44 oe*

**[7]**

**27.** (a) $\frac{5}{8}$

$\frac{5}{8}, \frac{3}{8}, \frac{5}{8}$ 2

*B1 for $\frac{5}{8}$ correct for $1^{st}$ counter*

*B1 for $\frac{5}{8}, \frac{3}{8}, \frac{5}{8}$ correct for $2^{nd}$ counter*

(b) $\frac{3}{8} \times \frac{3}{8}$

$\frac{9}{64}$ oe 2

*M1 for $\frac{3}{8} \times \frac{3}{8}$*

*A1 for $\frac{9}{64}$ oe*

**[4]**

**28.** (a) Correct diagram 2

*B1 for 0.2 oe seen on bottom left branc*

*B1 for correct probabilities on other branches*

(b) prob(*WW*) = 0.5 × 0.5

0.25 2

*M1for 0.5 × '0.5'*

*A1ft for 0.25 oe*

**[4]**

**29.** $\frac{5}{20}\times\frac{7}{19}+\frac{5}{20}\times\frac{8}{19}+\frac{7}{20}\times\frac{5}{19}+\frac{7}{20}\times\frac{8}{20}+\frac{8}{20}\times\frac{5}{19}+\frac{8}{20}\times\frac{7}{19}$

**or**

$\left(\frac{5}{20}\times\frac{15}{19}+\frac{7}{20}\times\frac{13}{19}+\frac{8}{20}\times\frac{12}{19}\right)$

**or**

$1-\left(\frac{5}{20}\times\frac{4}{19}+\frac{7}{20}\times\frac{6}{19}+\frac{8}{20}\times\frac{7}{19}\right)$

$\frac{131}{190}$ 4

*M1 for at least one product of the form* $\frac{a}{20}\times\frac{b}{19}$

*M1 for identifying all products*
*(condone 2 errors in 6 products, 1 error in 3 products)*
***Either***
$\left(\frac{5}{20}\times\frac{7}{19},\frac{5}{20}\times\frac{8}{19},\frac{7}{20}\times\frac{5}{19},\frac{7}{20}\times\frac{8}{19},\frac{8}{20}\times\frac{5}{19},\frac{8}{20}\times\frac{7}{19}\right)$
***or***
$\left(\frac{5}{20}\times\frac{15}{19},\frac{7}{20}\times\frac{13}{19},\frac{8}{20}\times\frac{12}{19}\right)$ **or**
$\left(\frac{5}{20}\times\frac{4}{19},\frac{7}{20}\times\frac{6}{19},\frac{8}{20}\times\frac{7}{19}\right)$

*M1 (dep) for*
$\left('\frac{5}{20}\times\frac{7}{19}+\frac{5}{20}\times\frac{8}{19}+\frac{7}{20}\times\frac{5}{19}+\frac{7}{20}\times\frac{8}{19}+\frac{8}{20}\times\frac{5}{19}+\frac{8}{20}\times\frac{7}{19}'\right)$
*oe*
***or*** $\left('\frac{5}{20}\times\frac{15}{19}+\frac{7}{20}\times\frac{13}{19}+\frac{8}{20}\times\frac{12}{19}'\right)$ *oe*
***or*** $1-\left('\frac{5}{20}\times\frac{4}{19}+\frac{7}{20}\times\frac{6}{19}+\frac{8}{20}\times\frac{7}{19}'\right)$ *oe*

*A1 for* $\frac{131}{190}$ *oe or 0.68947... correct to at least 2 decimal places or answer that rounds to 0.69*

***NB : If decimals used for products then must be correct to at least 2 decimal places***

***With replacement***
*M0*
*M1 for identifying all products*
*(condone 2 errors in 6 products, 1 error in 3 products)*
***either***

$\left(\frac{5}{20}\times\frac{7}{20},\frac{5}{20}\times\frac{8}{20},\frac{7}{20}\times\frac{5}{20},\frac{7}{20}\times\frac{8}{20},\frac{8}{20}\times\frac{5}{20},\frac{8}{20}\times\frac{7}{20}\right)$ ***or***

$\left(\frac{5}{20}\times\frac{5}{20},\frac{7}{20}\times\frac{7}{20},\frac{8}{20}\times\frac{8}{20}\right)$ **or**

$\left(\frac{5}{20}\times\frac{15}{20},\frac{7}{20}\times\frac{13}{20},\frac{8}{20}\times\frac{12}{20}\right)$

*M1 (dep) for*

$\left('\frac{5}{20}\times\frac{7}{20}+\frac{5}{20}\times\frac{8}{20}+\frac{7}{20}\times\frac{5}{20}+\frac{7}{20}\times\frac{8}{20}+\frac{8}{20}\times\frac{5}{20}+\frac{8}{20}\times\frac{7}{20}'\right)$

***or*** $\left('\frac{5}{20}\times\frac{15}{20}+\frac{7}{20}\times\frac{13}{20}+\frac{8}{20}\times\frac{12}{20}'\right)$

***or*** $1-\left('\frac{5}{20}\times\frac{5}{20}+\frac{7}{20}\times\frac{7}{20}+\frac{8}{20}\times\frac{8}{20}'\right)$

*A0 for* $\frac{262}{400}$ *oe or 0.655 (NB:* $\frac{262}{400}$ *oe or 0.655 implies M2)*

***Partial replacement***

*SC: B2 for* $\frac{141}{200}$ *oe or 0.705* ***or*** $\frac{121}{190}$ *oe or 0.6368… correct to at least 2 decimal places*

**[4]**

**30.** (a) 0.8,
0.4, 0.6, 0.4 — 2

*B1 for Julie correct*
*B1 for Pat correct*

(b) 0.12 oe — 2

$0.2 \times 0.6$

*M1 for* $0.2 \times 0.6$
*A1 cao*

**[4]**

**31.** (a) 0.7, 0.7, 0.3, 0.7 — 2

*B1 for Monday correct*
*B1 for Tuesday correct*

(b) 0.51 oe — 3

$1 - 0.7 \times 0.7$

*M1 for $0.7 \times 0.7$*
*M1 for 1 − "0.49"*
*A1 for 0.51 oe*
*(M1 for $0.3 \times 0.3$ **OR** $0.7 \times 0.3$ **OR** $0.3 \times 0.7$*
*M1 for $0.3 \times 0.3 + 0.7 \times 0.3 + 0.3 \times 0.7$*
*A1 for 0.51 oe)*

**[5]**

**32.** $\frac{660}{1000}$ oe — 5

Total = 3 + 5 + 2 (= 10)

$$\frac{3}{10}\times\frac{3}{10}\times\frac{5}{10}\left(=\frac{45}{1000}\right), \frac{3}{10}\times\frac{3}{10}\times\frac{2}{10}\left(=\frac{18}{1000}\right)$$

$$\frac{5}{10}\times\frac{5}{10}\times\frac{3}{10}\left(=\frac{75}{1000}\right), \frac{5}{10}\times\frac{5}{10}\times\frac{2}{10}\left(=\frac{50}{1000}\right)$$

$$\frac{2}{10}\times\frac{2}{10}\times\frac{3}{10}\left(=\frac{12}{1000}\right), \frac{2}{10}\times\frac{2}{10}\times\frac{5}{10}\left(=\frac{20}{1000}\right)$$

$$3\times\left(\frac{"45"}{1000}+\frac{"18"}{1000}+\frac{"75"}{1000}+\frac{"50"}{1000}+\frac{"12"}{1000}+\frac{"20"}{1000}\right)$$

$$\frac{660}{1000}$$

*M3 for all six expressions seen OR their combined equivalents*
*(M2 for four expressions seen OR their combined equivalents)*
*(M1 for two expressions seen OR their combined equivalents)*
*M1 sum of 18 relevant products condone 1 slip*
*A1 for $\frac{660}{1000}$ oe*
*SC: without replacement maximum M4 A0*
*SC: Just 2 beads: Answer either $\frac{38}{100}$ oe OR $\frac{28}{90}$ oe B1*

**[5]**

**33.** (a) 42g
8 — 3

Median at 50.5 (50)
100 – 92

*B1 for 42g to 43g*
*M1 for reading correctly from graph $\pm \frac{1}{2}$sq and subtracting from 100*
*A1 for 7, 8 or 9*

(b) cf — 2

*B1 for plots (condone one error) $\pm \frac{1}{2}$sq*
*B1 (dep) for joining points to give cf graph*
*SC: B1 if points plotted consistenly within intervals (condone one error) and joined*

(c) 0.0128 — 4

100 – 84 = 16
0.16
$0.08 \times 0.16$

*B1 for $\frac{"8"}{100}$ oe (Tawny Beach)*
*B1 for $\frac{15}{100}$ or $\frac{16}{100}$ or $\frac{17}{100}$ oe (Golden Beach)*
*M1 for multiplying two probabilities*
*A1 ft (dep on B2)*

**[9]**

**34.** $\frac{4}{9}$ oe — 4

$$\frac{2}{3} \times \frac{1}{3} + \frac{1}{3} \times \frac{2}{3}$$

*B1 for $\frac{2}{3}$ or $\frac{1}{3}$ seen*
*M1 for multiplying their P(H) by their P(T), $P(H) \neq P(T)$, $0 < \text{probs.} < 1$*
*M1 (dep) for × 2*
*A1 for $\frac{4}{9}$ oe OR $0.\dot{4}$ or 0.444(4…) no errors seen*

**[4]**

**35.** (a) 5 fractions 2

$\frac{4}{7}$ and $\frac{1}{4}$, $\frac{3}{4}$, $\frac{1}{4}$, $\frac{3}{4}$

*B1 for bag P correct*
*B1 for bag Q correct*

(b) $\frac{3}{28}$ oe 2

$\frac{3}{7} \times \frac{1}{4}$

*M1 for* $\frac{3}{7} \times$ "$\frac{1}{4}$" *(0 < 2nd fraction < 1)*
*A1*

**[4]**

**36.** £67.50 4

Paid in = 150 × £1.20 (= 180)
No. of winners =
$\frac{3}{10} \times 150 (= 45)$
Profit = "180" – "45" × 2.50

*B1 for 150 × 1.20 (= 180)*
*M1 for* $\frac{3}{10}$ *× "150" (= 45) or* $\frac{7}{10}$ *× "150"(= 105) or 54*
*M1 for "180" – "45" × 2.50 (= 180 – 112.50)*
*A1 for £67.50, £67, £68*
*Alternative method*
*B1 for 2.50 – 1.20 (= 1.30)*
*M1 for* $\frac{3}{10}$ *× "150" (= 45) or* $\frac{7}{10}$ *× "150"*
*M1 for "105" × 1.20 – "45" × "1.30"*
*A1 for £67.50, £67, £68*
*Alternative method*
*B1 for 0.3n × 2.50*
*M1 for 1.20n*
*M1 for (1.20n – 0.3n × 2.50) ×* $\frac{150}{n}$
*A1 for £67.50, £67, £68*

**[4]**

**37.** 14 3

$n = 21 \times 4$ or $\frac{1}{4} : \frac{1}{6}$

$\frac{1}{6} \times 84$ or $21 \times \frac{2}{3}$

*M1 for* $\frac{1}{3} \times \frac{3}{4} \left( = \frac{1}{4} \right)$ *or* $\frac{2}{3} \times \frac{1}{4} \left( = \frac{1}{6} \right)$

*M1 for* $21 \times 4 = 84$ *or* $\frac{21}{3} \times 2$

*A1 cao*

*[SC:B2 for answer of 63]*

**[3]**

**38.** (a) 0.6
0.3 0.4
0.6 2

*B1 for 0.3*
*B1 for 0.6, 0.4, 0.6*

(b) (0.7 × 0.6) + (0.3 × 0.4)
0.54oe 3

*M1 for either 0.7 × "0.6" or "0.3" × "0.4"*
*M1(dep) for (0.7 × "0.6") + ("0.3" × "0.4")*
*A1 cao*

**[5]**

**39.** (0.7 × 0.2) + (0.8 × 0.3) = 0.14 + 0.24
0.38 oe 3

*M1 for either 0.7 × 0.2 or 0.8 × 0.3*
*M1 for 0.7 × 0.2 + 0.8 × 0.3*
*A1 cao*
*SC: If no marks earned then B1 for fully correct tree diagram with probabilities shown*

**[3]**

**40.** (a) 1 – (0.3 + 0.25) 2
= 0.45 oe

*M1 for 1 – (0.3 + 0.25)*
*A1 for 0.45 oe*
*oe meaning that the probability must be given alternatively as a fraction (45/100 or an equivalent fraction), or as a decimal (45%).*
*Ratios, words (eg 45 to 100) get A0, could get M1 if working shown.*
*NB the decimal is not always clear; use working to clarify its existence if necessary, by 045 on the answer line without other working to substantiate should get 0 marks. Accept a comma for the decimal.*

(b) 0.3 × 200 2
= 60 or "60 out of 200"

*M1 for 0.3 × 200, or for sight of the number 60 on the answer line (eg in 60/200).*
*A1 cao*

**[4]**

**41.** 1 – P(2 greens) 3

$=1-\frac{5}{9}\times\frac{4}{8}$

$=1-\frac{20}{72}$

$=\frac{52}{72}$ oe

*M1 for p(2^nd stone) being a fraction with a denominator of 8*

*M1 for* $1-\frac{5}{9}\times\frac{4}{8}$ *oe or the sum of any 2 of:*

$\frac{4}{9}\times\frac{3}{8},\frac{4}{9}\times\frac{5}{8},\frac{5}{9}\times\frac{4}{8}$ *(ignore the sum of additional products)*

*A1 for* $\frac{52}{72}$ *oe [0.722…]*

*[SC: if no marks awarded, B1 for* $1-\frac{5}{9}\times\frac{5}{9}$ *oe]*

*OR if using a sample space approach:*
*M1 for correct table*
*M1 for correct identification of all the cases*
*A1 for* $\frac{52}{72}$ *oe [0.722…]*

**[3]**

**42.** 1 – 0.6 – 0.3 2
= 0.1

*M1 for 1 – (0.6 + 0.3) oe*
*A1 cao*

**[2]**

**43.** (a) 7/10 2/9, 7/9 3/9, 6/9 2

*B2 for all 5 correct*
*(B1 for 2, 3, or 4 correct)*

(b) $\frac{42}{90}$ 2

*M1 for "1st girl" × "2nd girl"*
*A1 cao.*

**[4]**

**44.** $\frac{2}{5}\times\frac{1}{6}\times\frac{3}{5}\times\frac{1}{2}$ 4

$= \frac{11}{30}$ oe

*M1 for* $\frac{3}{5}$ *or* $\frac{1}{6}$ *seen*
*(could be part of a calculation)*
*M1 indep for* $\frac{2}{5}\times\frac{1}{6}$ *oe or* $\frac{3}{5}\times\frac{1}{2}$ *oe*
*M1 for* $\frac{2}{5}\times\frac{1}{6}+\frac{3}{5}\times\frac{1}{2}$
*A1 for* $\frac{11}{30}$ *oe*

**[4]**

**45.** 4/7
5/11, 6/11, 5/11 2

*B2 for all four probabilities correct*
*(B1for 1 probability correct)*

**[2]**

**46.** $\left(\frac{3}{9}\times\frac{2}{8}\right)+\left(\frac{2}{9}\times\frac{1}{8}\right)+\left(\frac{4}{9}\times\frac{3}{8}\right)$

$=\frac{6+2+12}{72}$

$\frac{20}{72}$ 4

*B1 for $\frac{2}{8}$ or $\frac{1}{8}$ or $\frac{3}{8}$ seen as $2^{nd}$ probability*

*M1 for $\left(\frac{3}{9}\times\frac{2}{8}\right)$ or $\left(\frac{2}{9}\times\frac{1}{8}\right)$ or $\left(\frac{4}{9}\times\frac{3}{8}\right)$*

*M1 for $\left(\frac{3}{9}\times\frac{2}{8}\right)+\left(\frac{2}{9}\times\frac{1}{8}\right)+\left(\frac{4}{9}\times\frac{3}{8}\right)$*

*A1 for $\frac{20}{72}$ o.e.*

***Alternative scheme for replacement***

*B0 for $\frac{3}{9}$ or $\frac{2}{9}$ or $\frac{4}{9}$ seen as $2^{nd}$ probability*

*M1 for $\left(\frac{3}{9}\times\frac{3}{9}\right)$ or $\left(\frac{2}{9}\times\frac{2}{9}\right)$ or $\left(\frac{4}{9}\times\frac{4}{9}\right)$*

*M1 for $\left(\frac{3}{9}\times\frac{3}{9}\right)+\left(\frac{2}{9}\times\frac{2}{9}\right)+\left(\frac{4}{9}\times\frac{4}{9}\right)$*

*A0 for $\frac{29}{81}$*

***Special cases***

*S.C award B2 for $\frac{29}{81}$ or $\frac{20}{81}$ or $\frac{29}{72}$*

*SC award B1 for $\frac{2}{9}$ and $\frac{1}{9}$ and $\frac{3}{9}$ or $\frac{3}{8}$ and $\frac{2}{8}$ and $\frac{4}{8}$ seen as second probability if B2 not scored*

*Watch for candidates who misread the question and work with 10ths and 9ths They can score M2*

*Any other total for the number of yoghurts must be identified before ft*

**[4]**

**47.** (a) 1 – (0.2 + 0.35 + 0.2)

0.25 2

*M1 for 1 – (0.2 + 0.35 + 0.2)*
*A1 0.25 oe*
*SC: B1 for "1 out of 4" or "1 in 4"*
*SC: B1 if 0.25 seen in the table with incorrect answer on answer line.*

(b) 100 × 0.35
35 2

*M1 for 100 × 0.35*
*A1 cao*

**[4]**

**48.** $\frac{3}{8}\times\frac{2}{7}$
$\frac{6}{56}$ 3

*M1 for* $\frac{2}{7}$ *seen as non-replacement*
*M1 for* $\frac{3}{8}\times\frac{2}{7}, \frac{3}{8}\times\frac{3}{8}, \frac{3}{8}\times\frac{2}{8}, \frac{3}{8}\times\frac{3}{7}$ *oe seen*
*A1 for* $\frac{6}{56}$ *o.e.*

**[3]**

**49.** Reason 1

*B1 for indication of not enough trials*

**[1]**

**50.** (a) 4/5
(7/10, 3/10) (1/10, 9/10) 2

*B2 cao*
*(B1 for 2 correct from 4/5, (7/10, 3/10), (1/10, 9/10))*

(b) (1/5 × 7/10) + (4/5 × 1/10)
11/50 3

*M1 for 1/5 × "7/10" or "4/5" × "1/10" oe selected*
*M1 for (1/5 × 7/10) + (4/5 × 1/10) oe*
*A1 for 11/50 oe*

**[5]**

**51.** $\left(\frac{5}{10}\times\frac{7}{10}\right)+\left(\frac{5}{10}\times\frac{1}{10}\right)+\left(\frac{3}{10}\times\frac{2}{10}\right)+\left(\frac{3}{10}\times\frac{1}{10}\right)+\left(\frac{2}{10}\times\frac{2}{10}\right)+\left(\frac{2}{10}\times\frac{7}{10}\right)$

$= \frac{35+5+6+3+4+14}{100}$

**OR**

$1-\left[\left(\frac{5}{10}\times\frac{2}{10}\right)+\left(\frac{3}{10}\times\frac{7}{10}\right)+\left(\frac{2}{10}\times\frac{1}{10}\right)\right]$

$= 1-\frac{10+21+2}{100} = 1-\frac{33}{100}$

$\frac{67}{100}$ 4

*M1 for a tree diagram with at most 2 errors*
*or one of* $\left(\frac{5}{10}\times\frac{7}{10}\right)$ *or* $\left(\frac{5}{10}\times\frac{1}{10}\right)$ *etc*

*M1 for 5 out of 6 correct pairings of different colours*
*or 2 out of 3 correct pairings of same colours*
*or 8 out of 9 correct pairings of all colours*

*M1 (dep on M2) for adding 5 or 6 correct pairings of different colours*
*or 1 – (2 or 3 correct pairings of same colours)*

*A1 for* $\frac{67}{100}$ *oe*

***SC** All correctly done but* $2^{nd}$ *spinner all* $\frac{x}{9}$

*Award M1 for a "correct tree"*
*M1 for adding 5 or 6 "correct pairings" of different colours or*
*1 – (2 or 3 "correct pairings" of same colours)*
*M0 A0 (answer = 67/90)*

**[4]**

**52.** $\left(\frac{4}{9}\times\frac{3}{8}\right)+\left(\frac{3}{9}\times\frac{2}{8}\right)+\left(\frac{2}{9}\times\frac{1}{8}\right) = \frac{12+6+2}{72}$

$\frac{20}{72}$ oe — 4

*B1 for* $\frac{3}{8}$ *or* $\frac{2}{8}$ *or* $\frac{1}{8}$ *seen as* $2^{nd}$ *probability*

*M1 for* $\left(\frac{4}{9}\times\frac{3}{8}\right)$ *or* $\left(\frac{3}{9}\times\frac{2}{8}\right)$ *or* $\left(\frac{2}{9}\times\frac{1}{8}\right)$

*M1 for* $\left(\frac{4}{9}\times\frac{3}{8}\right)+\left(\frac{3}{9}\times\frac{2}{8}\right)+\left(\frac{2}{9}\times\frac{1}{8}\right)$

*A1 for* $\frac{20}{72}$ *oe*

***Alternative scheme for replacement***

*B0 for* $\frac{4}{9}$ *or* $\frac{3}{9}$ *or* $\frac{2}{9}$ *seen as* $2^{nd}$ *probability*

*M1 for* $\left(\frac{4}{9}\times\frac{4}{9}\right)$ *or* $\left(\frac{3}{9}\times\frac{3}{9}\right)$ *or* $\left(\frac{2}{9}\times\frac{2}{9}\right)$

*M1 for* $\left(\frac{4}{9}\times\frac{4}{9}\right)+\left(\frac{3}{9}\times\frac{3}{9}\right)+\left(\frac{2}{9}\times\frac{2}{9}\right)$

*A0 for* $\frac{29}{81}$

***Special cases***

*S.C. if M0 scored, award B2 for* $\frac{29}{81}$ *or* $\frac{20}{81}$ *or* $\frac{29}{72}$

*S.C. if M0 scored award B1 for* $\frac{3}{9}$ *or* $\frac{2}{9}$ *or* $\frac{1}{9}$

***or*** $\frac{3}{8}$ *and* $\frac{2}{8}$ *and* $\frac{4}{8}$ *as second probability if B2 not scored*

**[4]**

**01. Mathematics A Paper 4**

Part (a) was answered well by candidates of all abilities. Acceptable explanations often mentioned 100 as the expected number of sixes. The first mark in part (b) for writing $\frac{5}{6}$ on the "Not Six" branch was gained by many candidates but the tree diagram was often not completed correctly. Candidates commonly forgot labels, gave incorrect probabilities, or added only one more branch to the diagram.

**Mathematics B Paper 17**

Candidates of all abilities managed to gain credit in part (a) for a reasonable explanation of the problem. This was well answered. Candidates who failed to score usually offered a contradictory explanation.
A completely correct tree diagram in part (b) was rare. Most attempts had one branch only from each of the two given branches. 5/6 was often seen as the probability for the red dice not showing a six, and this was often the only mark gained.

**02.** Some of the most able candidates presented precise elegant solutions within a few lines of working. The vast majority of the non-A* candidates drew a tree diagram and proceeded to calculate the probabilities of all the possible combinations. Those who showed the results as double products of fractions generally scored more than half the marks for the question but those who evaluated without any evidence generally scored poorly. Many candidates did not go on to add the 18 relevant probabilities from their tree diagram. A high proportion of those who did attempt the correct sum made arithmetical errors.

**03.** Part (a) required candidates to comment on a statement about a probability. Most thought that the dice was unfair, maintaining that they would have expected 100 sixes. A few used the phrase ‘about 100 sixes’. Some did say that the dice was fair, because it is possible to get 200 out of 600 sixes from a fair dice.
Part (b) required candidates to complete a probability tree diagram. Most did so by drawing two more sets of two branches, correctly labelling and getting full marks. A few candidates thought that they should just draw 2 out of 4 branches. A few candidates drew the 4 branches but the probabilities on pairs of branches did not add up to 1.
Part (c) was a standard task and was well done by many candidates. The main error of good candidates was in (ii) where they interpreted the task as finding exactly one six. However, there were a sizeable number who thought that
$1 \times 1 = 2$ when multiplying the fractions together.

**04.** Many candidates did not realise that the numerical values given in the stem of the question had some relevance to the answer! Many candidates tried to argue that they may be dependent or not depending on whether they came to school together or not.
Some candidates did realise that for events to be independent Prob (both A and B) = Prob (A) × Prob (B) and were able to use the given information to come to the correct conclusion.

**05.** In part (a), most candidates applied a correct method but some left the answer as 7.4 or incorrectly rounded to 7. In part (b), a common wrong answer was 90. The final part of the question was answered well although some candidates failed to appreciate the need for a product and just gave the answer as $\frac{7}{18}$.

**06.** This was a complex probability question, involving either the use of the complementary event or a combination of 6 mutually exclusive events. Many candidates were able to sort out the correct combinations and then add the respective probabilities.

**07.** This was truly a question of "two halves". Part (a) was well answered. Nearly all candidates correctly gave the 0.4 on the left hand branch, and the majority went on to gain the second mark, but is was disappointing to find many errors on the right hand side, including careless reversals of the 0.6 and 0.4, or an apparent desire to make all four probabilities sum to 1. In Part (b) few gained any marks; there was little understanding of what the calculation of the mean involves.

**08.** **Mathematics A Paper 5**

The common error was to multiply the two probabilities.

**Mathematics B Paper 18**

Candidates were generally less successful with many multiplying the probabilities rather than adding them.

**09.** **Mathematics A Paper 5**

Although full correct solutions for this question were seen by the best candidates it was a rarity. Except for answers to (b)(i) it was unusual to find candidates at grade C and low B gain any further credit although some high grade B candidates scored 4 or 5 marks normally in parts (a) and (b). In part (a) those who applied a systematic approach were generally far more successful as illustrated by "2 × 98; 4 × 49; 28 × 7**" In part (b)(i) many of the given expressions were correct although $\frac{n}{n+7}$ was a common wrong answer. In part (b)(ii), although many could not present an adequate proof/explanation with a common wrong approach based on the 'fact' that "Bill is saying that there is only a total of 5 balls and we have 7 white balls", it was pleasing to find even some grade B candidates presenting a full logical proof based on $n$=10.5 and unable to have half a ball. Part (c) was very poorly answered with most just attempting to solve the equation (again). Of the reasonable attempts most gained credit for one product of two probabilities and a correct expansion of $(x\ \ 7)^2$ but many failed to eliminate the algebraic fractions correctly or missed out the second combination of probabilities. It was pleasing to find candidates recovering in the last part to gain a method mark for a relevant squaring of their answer to part (b)(i).

**Mathematics B Paper 18**

In part (a), the majority of candidates were unable to factorise the given expression. Of those who did obtain the correct factorisation a number then went onto solve the associated equation incorrectly with 7 (instead of $\frac{7}{2}$) being a popular incorrect solution. The majority of candidates were able to give the correct probability in part (bi) but then in (bii) were unable to offer a convincing proof that Bill's statement could not be correct. Part (c) was very poorly done with the majority of candidates starting with the equation given rather than using the information given to derive it. In part (d) very few candidates referred back to the expression for the probability quoted in (bi).

**10. Mathematics A Paper 6**

Parts (a) and (b) were well answered. There were a few candidates who thought the question was about sampling without replacement.
Part (c) proved to be more of a challenge, with many candidates failing to appreciate that the key idea involved find the total time for the original 30 CDs and subtracting the total time for the 5 CDs.

**Mathematics B**

**Paper 17**

All but a minority gained one mark in part (a), usually for a correct probability on the first branch of the tree diagram.
In part (b) only very few were able to gain any marks, usually 3 or nothing.

**Paper 19**

Part (a) was well done although some candidates did write the product of two probabilities for the second choice rather than the probability. The majority of candidates successfully answered part (b). A common error here was to add rather than multiply the two probabilities. Part (c) was very poorly done with the majority of candidates having no real idea how to tackle the question. The common incorrect approach was to calculate the difference between the mean playing times and subtract this from the mean playing time of all the CDs.

**11. Paper 4**

Overall this question was well answered, with over half the candidates gaining full marks. In part (a) a minority of candidates failed to give the correct answer. Their errors included writing the probability using incorrect notation, giving $^{1}/_{6}$, or just "30". Surprisingly a greater proportion of candidates gave the correct answer in part (b). The only significant errors in this part were the writing of the answer as a probability (eg 175/250) rather than a simple number, or performing a division: 25 ÷ 7.

**Paper 6**

Part (a) involves using the table to give an estimate of a probability.
Part (b) asked candidates to estimate the number of cases out of 250 based on a probability of 0.7. Virtually all candidates at this tier were able to do this. A few left the answer as a fraction with a denominator of 250.

**12.** This was an unstructured probability question. In the first part candidates had to realise that they had to use the probability of a 'not win' to get 0.55 × 0.45. This then has to be multiplied by 2 and evaluated. Some candidates drew a tree diagram and were able to add together 4 terms to get the correct answer of 0.495.
In the second part, candidates had to realise that there were three possible cases to consider. These were 'win, lose', 'lose, win' and 'draw, draw' over the two games. Many candidates were able to identify at least one of these terms but the overall success rate was not high.
Weaker candidates assumed that all possible cases were equally likely.

**13. Specification A**

A well answered question. The only common error was to use quarters on the right hand branches.

**Specification B**

¼ was often seen in the first pair of branches, gaining one mark, however there were many confused attempts at completing the second pairs of branches, often still using quarters.

**14.** Part (a) was generally done well.
In part (b), many candidates knew that they had to multiply and then add the probabilities, but only about half were able to do this accurately. A common error was $\frac{1}{4} \times \frac{1}{3} = \frac{2}{12}$.
Candidates generally found part (c) of this question difficult. Only the best candidates were able to achieve all the mark, though there were many that achieved at least one mark- usually for writing $\frac{3}{4} \times \frac{1}{3}$. Common answers were 63 and 84- which were awarded two marks.

**15.** Many candidates had a good idea of how to deal with the task in part (a). Some drew probability tree diagrams and were able to select the appropriate routes through the branches. Others simply wrote down the correct pair of products. The addition of the fractions was carried out well and the correct answer often seen. A very common error was to work out $\frac{1}{5} \times \frac{2}{5}$ as $\frac{3}{25}$. A common misread was to assume that the colours on the two dice were the same – red, blue and green. Part (b) was generally well answered. Most candidates realised that they had to work out the total income from 100 × 20p and then the expected payout from expected number of winners × 50p. A few candidates got confused and multiplied by 30p instead of 50p.

**16.** This question was usually well answered. Common misunderstandings included a reversal of the 2/7 and 5/7 on the bottom two branches, or a failure to use 7 in the denominator.

**17.** Most candidates inserted the correct fractions into the probability tree diagram. Part (b) was also well answered with the correct answer of $\frac{19}{35}$ often seen. Common occurring errors included a correct method, but with the multiplication carried out wrongly by making the denominators of the fractions the same, followed by incorrect multiplication. A few candidates thought that they had to add the fractions. They scored no marks.

**18.** Some weaker candidates gained marks in (a) and (b). In part (a), strong candidates gained a mark for substituting the values of *a, b* and *c* into the quadratic formula- those quoting the formula with greater success than those who didn't. The negative values of *b* and *c* proved a hurdle to many in their evaluation of $b^2 - 4ac$.
Part (b) was done well by the majority of candidates.
In part (c), only the best candidates gained any credit, usually for writing $\frac{n}{4(n+1)} \times \frac{3n+4}{4(n+1)} = \frac{14}{81}$. Those that went on to eliminate the fraction generally managed to complete the proof without error. Candidates that solved part (a) correctly usually gained the mark for part (d). A significant number of candidates solved 4 ( n+ 1)=36 to get $n$ = 8, but did not then relate this to part (a). A few recovered by listing 8, 10 and 18.
In part (e), an encouraging number of candidates could add the product of three fractions, usually $P(RB)$, $P(RW)$ and $P(RW)$ which were often derived from a tree diagram. Final answers were usually given as a fraction.

**19.** **Specification A**

The tree diagram was completed correctly by more than half of the candidates. It was not surprising that most errors were made on the bottom two right hand branches.

**Specification B**

Most candidates scored at least one mark here, usually for correctly labelling the $\frac{1}{4}$ in the first branch. Failure in the second branches often arose from including quarters in one or more of the probabilities.

**20. Specification A**

The probability tree diagram was generally completed correctly. Part (b) was almost always answered using a correct method although there were the occasional errors of $\frac{3}{4} \times \frac{1}{3} = \frac{4}{12}$.
Answers to part (c) were also good, but less successful than part (b). There were the usual errors of confusing the use of multiplication and addition in the method as well as the accuracy errors of the type outlined for part (b).

**Specification B**

The tree diagram in part (a) was completed correctly by over 90% of candidates. Parts (b) and (c) were generally well answered although more candidates than usual attempted to add rather than multiply the relevant probabilities. A few candidates indicated that they knew that the relevant probabilities in (a) needed to be multiplied but then went on to add them regardless.

**21.** The majority of candidates were able to complete the tree diagram in part (a). In part (b), most candidates knew that they were required to multiply 0.4 by 0.4 but a large proportion of these had problems in doing this- typically giving their answer as 1.6 or 0.8. Relatively few added the probabilities.

**22.** Most competent candidates drew a tree diagram and were able to identity the correct branches and carry out the appropriate calculations. A few candidates forgot that there were two possible ways in which the required outcome could happen and so only gained half marks.

**23.** Part (a) of this question was done well by the majority of candidates, scoring at least one mark for 0.6 on the first branch.

In parts (b) and (c), candidates often identified the correct probabilities, but a significant number were confused about that operations they should be using. A popular error was to add the probabilities along the branches instead of multiplying them. A surprising number of those candidates who multiplied probabilities were unable to do this correctly, e.g. 0.3 × 0.4 was often evaluated as 1.2. In part (c), many candidates worked with the correct two pairs of branches, but many of these were confused about the order of the operations; a common incorrect method was (0.6 + 0.7) × (0.6 + 0.3). A popular incorrect answer was 4.6

As the question was written in decimals most candidates kept the probabilities in this form, it was noted, however, that those candidates who converted their decimals to fractions were often more accurate with their answers than those that hadn't.

**24.** This was a reasonably demanding probability question as candidates had to decide what approach to take. Many decided to draw a tree diagram and then identify which were the relevant branches. They tended to be more successful than those who did not draw the probability tree. Often, those candidates identified the expressions $\frac{4}{7}\times\frac{3}{7}\times\frac{3}{7}$ and $\frac{4}{7}\times\frac{4}{7}\times\frac{3}{3}$ but then acted as if these were the only 2 cases or doubled both probabilities giving a total of 4 cases.

A few candidates dealt with the complementary event and calculated $1-\left(\frac{4}{7}\right)^3-\left(\frac{3}{7}\right)^3=\frac{252}{343}$.

**25.** Part (a) was well answered. Very few candidates thought that this was sampling without replacement.

Answers to part (b) were split between the correct 0.2 × 0.2 and the incorrect 0.2 + 0.2, although some candidates evaluated the former as 0.4

Answers to part (c) generally considered some of the 5 cases. Quite often the answer 0.2 was seen from 0.58 × 0.2 + 0.22 × 0.2 + 0.2 × 0.2 or the answer 0.32 from (0.58 × 0.2 + 0.2) × 2

The approach 1 – P(No jazz) was rarely seen, but usually led to the correct answer.

**26.** Part (a) was done well by the vast majority of the candidates. In part (b), many candidates knew that they needed to multiply the probabilities but a significant number of these were unable to do the calculation accurately, e.g. 0.8 × 0.6 = 4.8 or 0.42. Common incorrect methods were 0.8 + 0.6 = 1.4 and $\frac{0.8+0.6}{2} = 0.7$. In part (c), only the best candidates were able to score full marks for this question, but many were able to score 1 mark for either 0.8 × 0.4 or 0.2 × 0.6. Common errors here were similar to those in part (b), e.g. those involving poor arithmetic, e.g. 0.8 × 0.4 = 3.2, 0.24 or 2.4, or those involving confusion as to when to multiply the probabilities or when to add the probabilities, e.g. (0.8 + 0.4) × (0.2 + 0.6).

**27.** Accurate completion of the probability tree diagram was good with most candidates scoring at least one mark. In part (b) however a great many candidates added the probabilities instead of multiplying. It is also of note that of the candidates who correctly quoted $\frac{3}{8}\times\frac{3}{8}$ a significant number failed to correctly work out this product; $\frac{9}{16}$ being a common error.

**28.** Very few candidates failed to score any marks at all in this question.

Part (a) was answered very well with most candidates completing the probability tree diagram correctly. Errors usually occurred on the right hand branches where some candidates put the values 0.5, 0.3 and 0.2 in the wrong order and some inserted the results of multiplying two probabilities together. A significant number of candidates were not aware that they needed to multiply the probabilities on the relevant branches in part (b) and many added 0.5 to 0.5 instead. Even when candidates did write down 0.5 × 0.5 this was sometimes evaluated incorrectly with answers of 0.5, 1 and even 2.5 seen quite frequently. Some candidates with incorrect answers lost the opportunity of gaining a method mark here because they did not show any working.

**29.** A large number of candidates drew tree diagrams, which in most cases were helpful: however some candidates drew them so big that their calculations were then squashed around the edges with very little logical flow. Most candidates seemed to have assumed that there was replacement and so limited themselves to 2 out of the four marks. It was common to consider only three scenarios instead of 6, for example red then orange but not orange then red. It was more common to see 6 fractions added rather than 1 – the complement.

**30.** Part (a) was generally well done. However, a number failed to get the correct entries for Pat. Part (b) could be done independently of the probability tree diagram. Many candidates wrote down the correct expression of 0.2 × 0.6 and obtained the answer 0.12. However, a significant number of candidates gave an answer of 1.2. The incorrect method of 0.2 + 0.6 was frequently seen.

**31.** Part (a) was well answered. In part (b) the majority of candidates found one product correctly but few were able to demonstrate a fully correct method often failing to appreciate the mathematical meaning of ‘at least’. It is disappointing to report that many could not correctly find the value of the individual products and some final answers were even greater than one.

**32.** The majority of candidates were able to attempt this question. A few candidates simply drew the relevant tree diagram and failed to give any probabilities. Of those candidates who did use probabilities, most were able to score at least 3 of the available 5 marks. Those who did not score full marks generally failed to recognise that the order that the beads were selected was important and thus red, red, green had to be included as well as red, green, red and green, red, red.

**33.** Parts (a) and (b) were well done by the majority of candidates. In part (c) most candidates were able to write down the relevant probabilities correctly but these were then frequently added rather than multiplied. A common arithmetic error in this question was to give the answer to $100 \times 100$ as 1000.

**34.** Many good candidates scored some marks in answering this question. Some failed to find the correct probabilities for heads or tails from the information given but realised that they probabilities they had found needed to be multiplied. Fewer candidates added the two relevant probabilities. Greater success came from those candidates who worked entirely in fractions than decimals. Weaker candidates seemed happy to use probabilities grater than 1.

**35.** Completion of the tree diagram was well done by the vast majority of candidates. In part (b) a significant number of candidates added rather than multiplied the probabilities. The main concern, however, was candidates’ failure to always evaluate the fraction product correctly. It is worth noting that section B is a calculator section and so the product should not have been a problem. A common error was $\frac{3}{7} \times \frac{1}{4} = \frac{4}{28} = \frac{1}{7}$ or, perhaps worse in a probability question, $\frac{3}{7} \times \frac{1}{4} = \frac{12}{28} \times \frac{7}{28} = \frac{84}{28} = 3$

**36.** This was an unfamiliar type of question for candidates but was one that was generally well answered. Over 85% of candidates were able to score at least one mark for their solution with just over 60% of candidates gaining full marks. A common error was for candidates to equate $\frac{3}{10}$ to $\frac{1}{3}$ in their calculation.

**37.** Over 60% of candidates used the probabilities on the tree diagram correctly and indicated that they would multiply appropriate probabilities. Unfortunately, many arithmetic errors were then seen; a significant number of candidates added rather than multiplied the probabilities. A common error was to give the answer as 63 coming from subtracting the number of times both games were won from the total number of games played.

**38.** Part (a) was answered correctly by the majority of candidates. Candidates generally had much less success with part (b) which was poorly done. A significant number of candidates added the probabilities and then averaged these. Another incorrect method was to find the two correct products but then multiple these instead of adding them.

**39.** The unstructured nature of this question made it more demanding for candidates. Many were able to draw a correct tree diagram and progress to finding the required probability. A number of candidates added instead of multiplying the appropriate probabilities. The most common error was either to evaluate the probability of passing both exams or to evaluate the probability of passing at least one exam.

**40.** The majority of candidates gained full marks in part (a). A surprising number gave 0.28 as the sum of 0.3 and 0.25, leading to the answer of 0.72. This was a common error, which is all the most disappointing since this is a calculator error. Was this an indication of the absence of a calculator? Or were many candidates trusting to poor arithmetic and not checking their work with their calculator? Those candidates who did not understand the process of relative probability performed a division rather than a multiplication in part (b). There were few who gave their answer as a probability rather than as a quantity. Most gained full marks.

**41.** It was encouraging to see so many candidates who clearly understood that fractions of 9, then 8 were needed. These were commonly expressed on a probability tree diagram. A small number attempted to add the probabilities, rather than multiplying. Many calculated the four products, but then had difficulty in picking those that were needed to answer the question. It is discouraging to see many failed attempts to cancel fractions, particularly when candidates have arrived at the correct answer.

**42.** This question was very well answered with most candidates gaining both marks.

**43.** Candidates clearly understood the concept of a tree diagram and there were many fully correct answers to this question. A significant minority of candidates however, did not recognise this as a "non-replacement" situation and marked the same probabilities ($\frac{3}{10}$, $\frac{7}{10}$) on the second stage of their diagram. Although these candidates were unable to gain any marks for at least two correct probabilities in part (a), many used their probabilities correctly in part (b) to gain some credit in that part of the question. In part (b) some candidates failed to identify the need to multiply two probabilities and disappointingly, a significant number attempted to add the probabilities, sometimes giving numbers greater than one as their answers. $\frac{13}{19}$ was often seen following $\frac{7}{10}+\frac{6}{9}$. A number of candidates misread the question and gave the probability of at least one girl. Candidates who worked out the correct answer ($\frac{42}{90}$) but failed to simplify their fraction correctly were not penalised as the question was not testing this skill. This does however confirm the need for candidates to show their method clearly in the space for working. The need to show working was also highlighted by those candidates who knew they had to multiply, and wrote this down, but had insufficient ability with fractions to complete this correctly and those who could not correctly multiply 6 by 7.

**44.** Over half the candidates were able to access the first mark by showing that not stopping at one of the lights was 3/5 or 1/6. A further 12% then went on to gain the second mark by showing 3/5 × 1/2 or 2/5 × 1/6. However poor arithmetic let many candidates down with 2/5 × 1/6 = 3/30 commonly seen. Even those candidates who did get to 3/10 + 2/30 then went on to write 5/40. Some overlooked the different probabilities at the second set of lights and assumed 5/6 and 1/6 on both branches. This led to answers of (2/5 × 1/6) + (3/5 × 5/6) = 17/30. A significant minority obtained a correct tree and then tried to add probabilities. Yet others seemed to think that a common denominator was needed when multiplying fractions often introducing arithmetic errors as a result.

**45.** This question was well understood but it was surprising to see so many candidates making errors in labelling the probabilities for snooker. The Darts "Not win" was almost correctly labelled by 96% of candidates but they often switched the probabilities for "win" and "not win" for snooker.

**46.** This was a fairly standard, but non-trivial, probability question. Many successful candidates drew correct probability tree diagrams and used them properly. 24% of candidates knew that they had to multiply the probabilities together as they worked along a set of branches starting with the root and were then able to add the resulting 3 fractions correctly to get the right answer. However, there were a large number of errors due to inability to tackle the arithmetic of fractions correctly. These were of the following general types:

- carelessness, exemplified by one of $\frac{3}{9}\times\frac{2}{8}=\frac{5}{72}$ or $\frac{2}{9}\times\frac{1}{8}=\frac{3}{72}$
- confusion over multiplication, exemplified by all of $\frac{3}{9}\times\frac{2}{8}=\frac{5}{72}$,
  $\frac{2}{9}\times\frac{1}{8}=\frac{3}{72}$ and $\frac{4}{9}\times\frac{3}{8}=\frac{7}{72}$
- confusion over multiplication as exemplified by $\frac{3}{9}\times\frac{2}{8}=\frac{42}{72}$ or $\frac{3}{9}\times\frac{2}{8}=\frac{432}{72}$
- confusion over addition as exemplified by $\frac{6}{72}+\frac{2}{72}+\frac{12}{72}=\frac{20}{216}$

Many candidates made life harder for themselves by calculating the correct fractions for the cases SS, PP and CC, cancelling them and then making an error on the addition of the three fractions with different denominators.

Some candidates treated the problem as one of replacement and were rewarded as they had essentially the correct method.

Some candidates thought the total of yoghurts was 8 rather than 9 and ended up with a fraction over 56 and there were also some candidates who tried to eat 3 yoghurts.

Other candidates gave fractions such as prob. (2nd is S) = $\frac{2}{9}$ rather than $\frac{2}{8}$.

Some candidates drew out the whole equally likely sample space for the case with replacement and obtained the answer $\frac{29}{81}$

There were, of course many candidates who tried to draw a probability tree but could not get its structure correct (generally they did not have 3 branches from every node) and many others who could not get as far as that. 45% of candidates scored no marks.

**47.** This question was well answered. In part (a) the vast majority of candidates (94%) were successful with only a small minority of weaker candidates extending a perceived number sequence to give “0.35” as their answer. Other candidates were unable to add probabilities or subtract their total from one accurately and so did not gain full credit for their answer to this part of the question. Not quite as many candidates (77%) successfully completed part (b). Some candidates gave the answer “25” apparently either dividing the total frequency into 4 equal parts or using the answer to part (a) rather than the “0.35” required from the table. “35/100” appeared fairly frequently and was awarded one mark.

**48.** This question proved to be a good discriminator. A majority of candidates were able to identify that the question involved non-replacement and secured the first available mark for sight of “$\frac{2}{7}$”.

Over a third of candidates went on to give the correct answer $\frac{6}{56}$ or equivalent. However, for others, the inability to manipulate fractions let them down. For example, candidates often used a correct method but ended their answer with “$\frac{3}{8}\times\frac{2}{7}=\frac{5}{56}$” Some candidates accounted for several different outcomes in their answer.

**49.** This question was not answered well. Only about a third of the candidates realized that they had to comment on the frequency of the trials of the experiment. Common unacceptable answers here were, e.g. “the dice has an equal chance of landing on the numbers” and “if she kept rolling the dice it would land on a 1”.

**50.** A considerable number of candidates were able to score full marks on this question.

Most candidates were able to score at least 1 mark in part (a). Common incorrect answers here include reversing the positions of 1/10 and 9/10 on the bottom right hand branches of the tree diagram, and giving both pairs of branches on the right hand side of the tree diagram as the same fractions (usually 7/10 and 3/10).

In part (c), the many candidates were able to write down 1/5 × 7/10 for one of the ways that Nicola could be late, but neglected to consider the other way (i.e. 4/5 × 1/10). Other common errors were based on a confusion in the required processes, e.g. $\left(\frac{1}{5}\times\frac{7}{10}\right)+\left(\frac{4}{5}\times\frac{1}{10}\right)$; or in a misunderstanding of how to interpret a tree diagram, e.g. $\frac{7}{10}\times\frac{1}{10}$. Examiners reported a general weakness in the candidates’ ability to deal with fractions.

**51.** There were some excellent answers to this question in which a correctly drawn probability tree was constructed carrying the correct probabilities on each branch. The six required probability products were then identified leading to the final probability of 67/100. Over 20% of the candidates got this question fully correct with a further 6% only making one slip. The alternative methods being used in an attempt to arrive at the final answer did, however, seemed to be less successful. An abundance of fractions in the subsequent working very often left the student wondering how to combine them together into one single probability. There was some evidence of non-replacement seen thus making the question much more difficult than it need have been.

The fractions manipulation within the working is clearly an area of weakness as some found difficulty in combining fractions together. For example 5/10 × 7/10 ended up as 35/20, 12/100, and any other combination of the four numbers. Cancelling the fractions down before multiplying 5/10 × 7/10 = ½ × 7/10 = 7/20 was fine but then presented a problem when they had to add together fractions with different denominators. As a general rule it would be easier to achieve the final result if the fractions are not cancelled down. 60% of the candidates failed to score any marks on this question. Many had little idea what to do, though realising it involved the fractions 1/10; 2/10; 7/10 etc, then writing down some simple combination of these fractions, including multiplying 3 together, adding or taking away. Others had a separate tree diagram for each spinner, showing one or two throws but were then not sure what to do with their answers. Candidates using decimal notation also demonstrated correct tree diagrams but many had difficulty multiplying e.g. 0.2 × 0.2 correctly (the usual answer being 0.4).

**52.** This was a fairly standard, but non-trivial, probability question. Many successful candidates drew correct probability tree diagrams and used them properly. 21% of candidates knew that they had to multiply the probabilities together as they worked along a set of branches starting with the root and a further 36% of candidates knew they had to be to add the resulting 3 fractions to get the right answer. However, there were a large number of errors due to inability to tackle the arithmetic of fractions correctly. These were of the following general types:

- carelessness, exemplified by one of $\frac{3}{9}\times\frac{2}{8}=\frac{5}{72}$ or $\frac{2}{9}\times\frac{1}{8}=\frac{3}{72}$
- confusion over multiplication, exemplified by all of $\frac{4}{9}\times\frac{3}{8}=\frac{7}{72}$,
  $\frac{3}{9}\times\frac{2}{8}=\frac{5}{72}$ and $\frac{2}{9}\times\frac{1}{8}=\frac{3}{72}$
- confusion over multiplication as exemplified by $\frac{3}{9}\times\frac{2}{8}=\frac{42}{72}$ or $\frac{3}{9}\times\frac{2}{8}=\frac{432}{72}$
- confusion over addition as exemplified by $\frac{6}{72}+\frac{2}{72}+\frac{12}{72}=\frac{20}{216}$

Many candidates made life harder for themselves by calculating the correct fractions for the cases OO, AA and TT, cancelling them and then making an error on the addition of the three fractions with different denominators.

Some candidates treated the problem as one of replacement and were rewarded as they had essentially the correct method.

Some candidates thought the total of bottles was 8 or 10 rather than 9 and ended up with a fraction over 56 or 90 and there were also some candidates who tried to drink 3 bottles or convert to decimals.

Other candidates gave fractions such as probability(2nd is O) = $\frac{2}{9}$ rather than $\frac{2}{8}$.

Some candidates drew out the whole equally likely sample space for the case with replacement and obtained the answer $\frac{29}{81}$

There were, of course many candidates who tried to draw a probability tree but could not get its structure correct (generally they did not have 3 branches from every node) and many others who could not get as far as that.

It was pleasing however to see that fully correct solutions were given in 30% of cases though 44% of candidates scored no marks.