**1(a).** A bag only contains green, red, blue and yellow discs.

Mei carries out an experiment.
She picks one disc at a time from the bag, records its colour and then returns the disc to the bag.
When she has finished the experiment, Mei works out the relative frequency of each colour.
Some of her results are shown in the table.

| **Colour** | Green | Red |
|---|---|---|
| **Relative frequency** | 0.25 | 0.15 |

The relative frequency of the yellow discs was five times the relative frequency of the blue discs.

In total, there are 3000 discs in the bag.

Use this information to find an estimate for the **total** number of green and yellow discs that are in the bag.
You must show your working.

..... **[5]**

**(b).** Explain why your estimate may **not** be reliable.

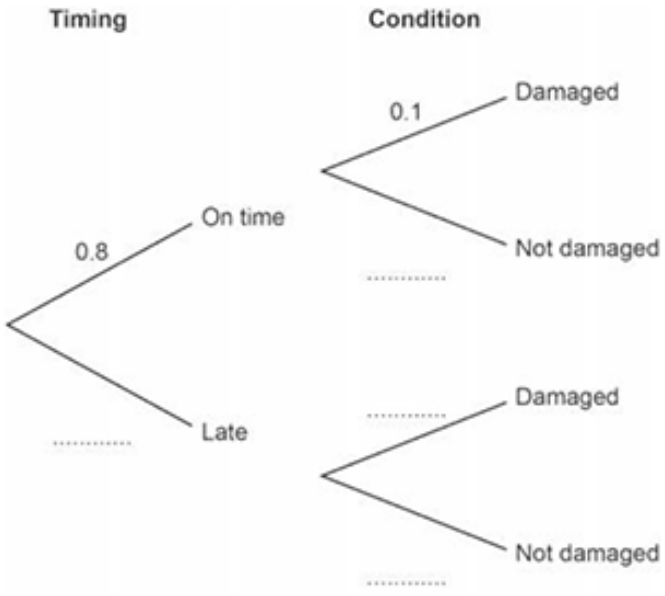
---

---**[1]**

**2(a).** An online company is tracking the timing and condition of its deliveries.

The probability that a parcel arrives on time is 0.8.
When the parcel arrives on time, the probability that it is damaged is 0.1.
When the parcel arrives late, the probability that it is damaged is 0.2.

Use the information to complete the tree diagram.

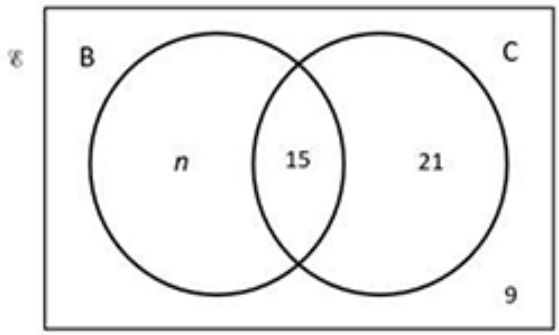



**[3]**

**(b).** Given that a parcel arrives damaged, find the probability that it also arrived on time.

.....**[4]**

**3(a).** In a survey, some students were asked whether they had travelled to school by bus (B) or by car (C) in the last week.
The Venn diagram shows some of the results.




One of the students is chosen at random.

The probability that, in the last week, this student had travelled to school by bus and by car is $\frac{1}{5}$.

Find the value of *n*.

*n* = ..... **[3]**

**(b).** One of the students is chosen at random.

Find the probability that, in the last week, this student had travelled to school by car given that they had also travelled to school by bus.

..... **[2]**

**4.** An app's passcode consists of three digits. Each of the digits is a number from 1 to 5.
A digit can be used more than once.

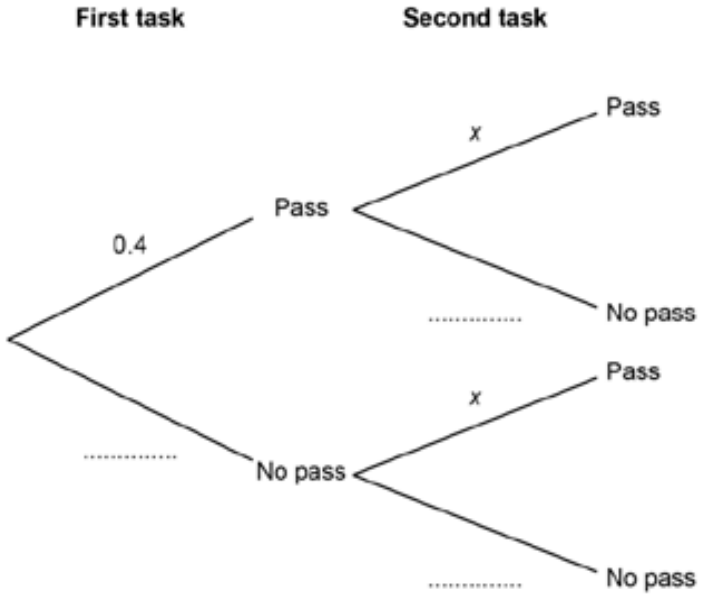
Find the fraction of the possible passcodes that contain at least one 2.

..... **[4]**

**5(a).** A student attempts two tasks.
The result of each task is either "Pass" or "No pass".

The probability of the student passing the first task is 0.4.
The probability of the student passing the second task is *x*.

Complete the tree diagram.




**[2]**

**(b).** Write down the mathematical assumption that has been made about the two tasks.

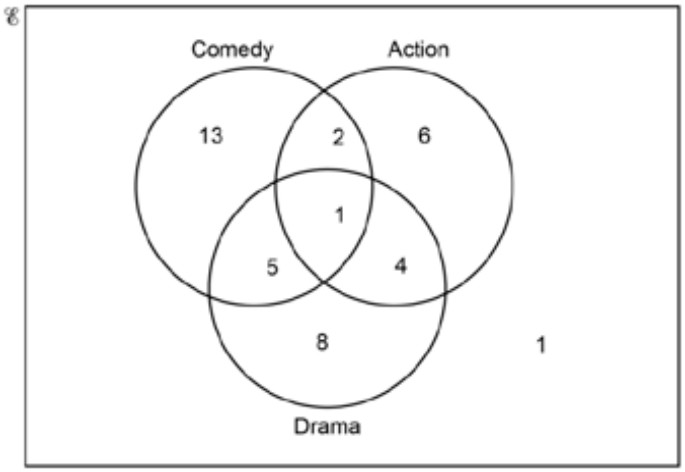
**[1]**

**(c).** The probability of the student passing just one of these two tasks is 0.472.

Work out the value of $x$.

$x$ = ..... **[4]**

**6(a).** In a survey, 40 people are asked which type of films they watch.
The results are shown on the Venn diagram.




One person is chosen at random from those that watch action films.

Find the probability that this person watches **only one** other type of film.

..... **[2]**

**(b).** Two of the 40 people are chosen at random.
Show that the probability that one of them watches **only** comedy films and the other watches **only** drama films is $\frac{2}{15}$.

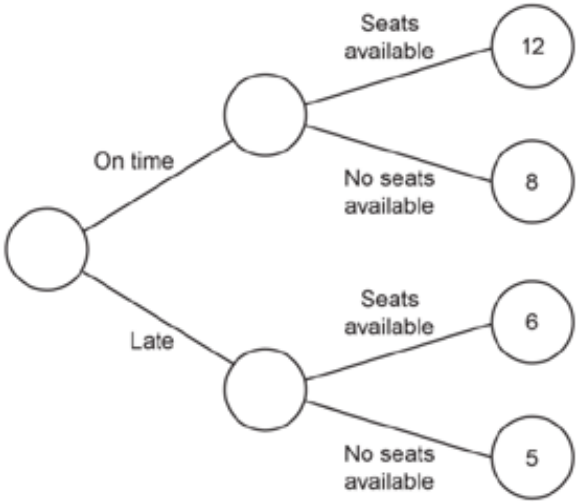
**[3]**

**7.** Kareem travels to work each day by train.

He records whether

- the train is on time or late
- there are seats available or no seats available.

Kareem's results are shown on this partly completed frequency tree.



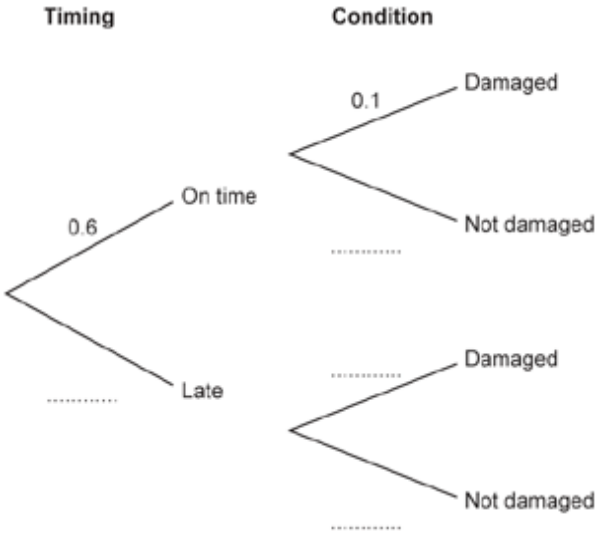

Find the relative frequency of there being no seats available on Kareem's train journey.

..... **[2]**

**8(a).** An online company is tracking the timing and condition of its deliveries.

The probability that a parcel arrives on time is 0.6.
When the parcel arrives on time, the probability that it is damaged is 0.1.
When the parcel arrives late, the probability that it is damaged is 0.3.

Use the information to complete the tree diagram.



**[3]**

**(b).** Given that a parcel arrives damaged, find the probability that it also arrived on time.

..... **[4]**

**9(a).** A bag only contains green, red, blue and yellow discs Orla carries out an experiment.
She picks one disc at a time from the bag, records its colour and then returns the disc to the bag.
When she has finished the experiment, Orla works out the relative frequency of each colour.
Some of her results are shown in the table.

| **Colour** | Green | Red |
|---|---|---|
| **Relative frequency** | 0.35 | 0.25 |

The relative frequency of the yellow discs was three times the relative frequency of the blue discs.

In total, there are 2000 discs in the bag.

Use this information to find an estimate for the **total** number of green and yellow discs that are in the bag.
You must show your working.

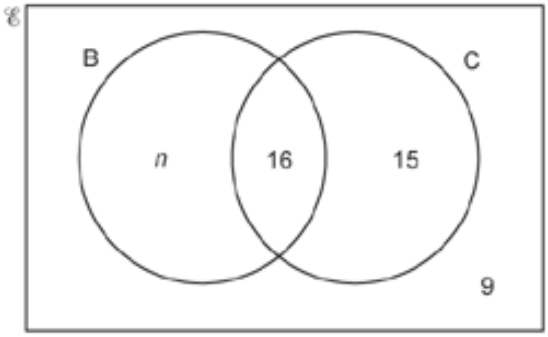
..... **[5]**

**(b).** Explain why your estimate may **not** be reliable.

---

**[1]**

**10(a).** In a survey, some students were asked whether they had travelled to school by bus (B) or by car (C) in the last week.
The Venn diagram shows some of the results.




One of the students is chosen at random.

The probability that, in the last week, this student had travelled to school by bus and by car is $\frac{1}{4}$.
Find the value of $n$.

$n$ = ..... **[3]**

**(b).** One of the students is chosen at random.
Find the probability that, in the last week, this student had travelled to school by car given that they had also travelled to school by bus.

..... **[2]**

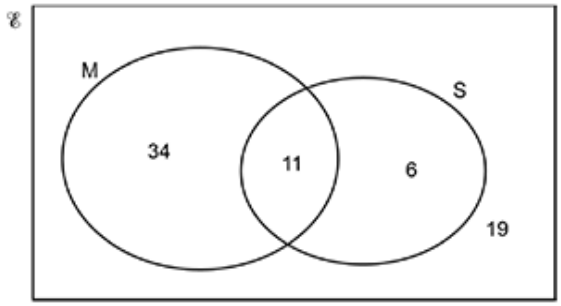
**11.** An app's passcode consists of three digits. Each of the digits is a number from 0 to 9.
A digit can be used more than once.

Find the fraction of the possible passcodes that contain at least one 5.

..... **[4]**

**12(a).** A cafe owner recorded information about customer orders for coffee.
They recorded whether the customer asked for milk (M) and whether the customer asked for sugar (S).

The results are shown in this Venn diagram.




One of the customers is chosen at random.

Find the probability that the customer asked for milk.

..... **[2]**

**(b).** One of the customers is chosen at random.

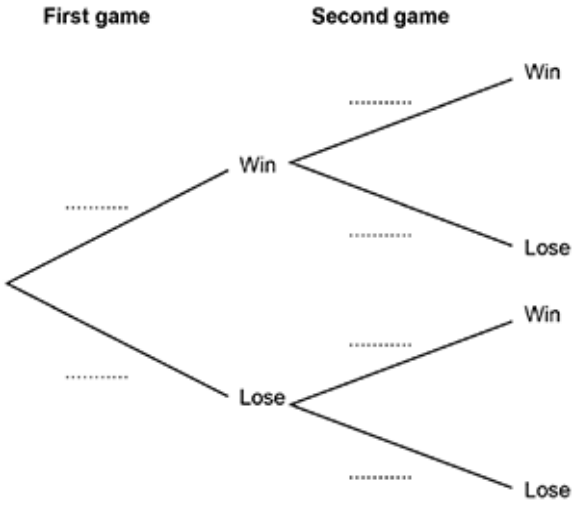
Find the probability that the customer asked for milk given that they asked for sugar.

..... **[2]**

**13(a).** In a computer game the player can either win or lose.
A student thinks the ratio of the probability of winning to the probability of losing is 3 : 7.

The student plays two games.

Use the information to complete the tree diagram.




**[3]**

**(b).** Find the probability that the student loses at least one of the two games.

..... **[3]**

**(c).** The student now thinks the ratio of the probability of winning to the probability of losing has changed to 3 : 5.

Explain the effect this change will have on your answer to part **(b)**.

---

---**[1]**

**14.** Charlie has a set of cards.
Each card has a cross or square drawn on it and is coloured green or yellow.

The table gives some information about the number of each type of card.

| | **Number of cards with a cross** | **Number of cards with a square** |
|---|---|---|
| **Number of yellow cards** | 4 | 7 |
| **Number of green cards** | 8 | 3 |

Charlie chooses three of these cards at random without replacement.
All three of these cards have a square drawn on them.

Charlie says

*The probability that two of these three cards are yellow and one is green is less than* $\frac{1}{2}$.

Is Charlie correct?
You must show your working.

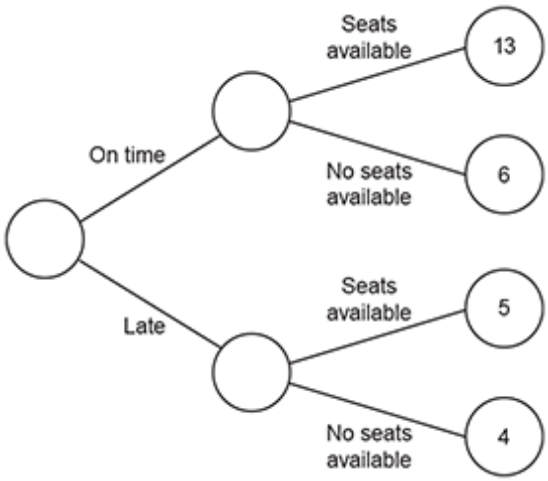
**[5]**

**15.** Jack travels to work each day by train.

He records whether

- the train is on time or late
- there are seats available or no seats available.

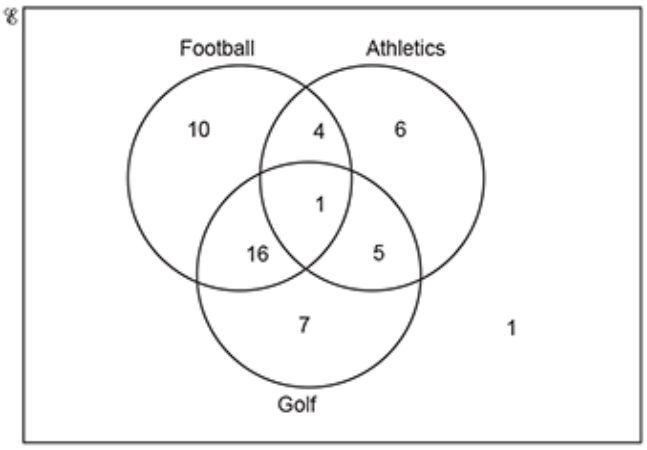
Jack's results are shown on this partly completed frequency tree.




Find the relative frequency of there being no seats available on Jack's train journey.

..... **[2]**

**16(a).** In a survey, 50 people are asked which sports they watch.
The results are shown on the Venn diagram.




One person is chosen at random from those that watch athletics.

Find the probability that this person watches **only one** other sport.

..... **[2]**

**(b).** Two of the 50 people are chosen at random.

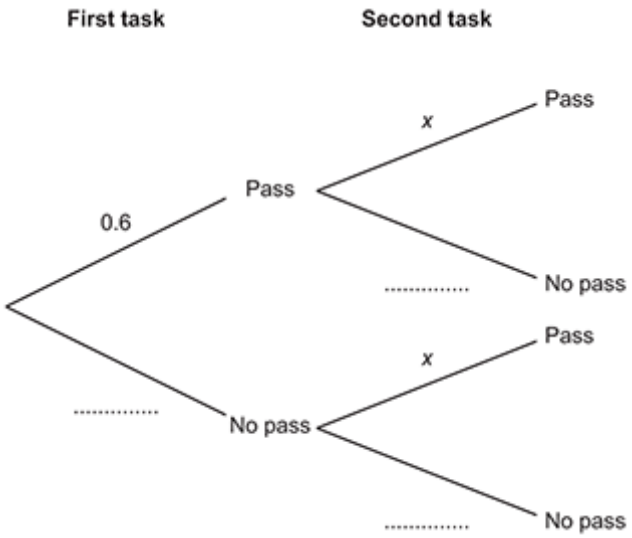
Show that the probability that one of them watches **only** football and the other watches **only** golf is $\frac{2}{35}$.

**[3]**

**17(a).** A student attempts two tasks.
The result of each task is either “Pass” or “No pass”.

The probability of the student passing the first task is 0.6.
The probability of the student passing the second task is $x$.

Complete the tree diagram.




**[2]**

**(b).** Write down the mathematical assumption that has been made about the two tasks.

---

---

**[1]**

**(c).** The probability of the student passing just one of these two tasks is 0.528.

Work out the value of $x$.

$x$ = ..... **[4]**

**18(a).** The time, *t* minutes, taken by each of 70 students to complete a sponsored walk is recorded.

The table shows information about these times.

| **Time (*t* minutes)** | $40 < t \leq 50$ | $50 < t \leq 60$ | $60 < t \leq 70$ | $70 < t \leq 80$ | $80 < t \leq 90$ |
|---|---|---|---|---|---|
| **Frequency** | 18 | 32 | 15 | 0 | 5 |

Two students are picked at random.
Jamal works out the probability that they both took 60 minutes or less to complete the sponsored walk.
Jamal's working is shown below.

The number of students who took 60 minutes or less is 18 + 32 = 50

The probability that one student took 60 minutes or less is $\frac{50}{70} = \frac{5}{7}$

The probability they both took 60 minutes or less is $\frac{5}{7} \times \frac{5}{7} = \frac{25}{49}$

Explain the error in their method and write the correct calculation that Jamal needs to do.
You do not need to work out the answer to the calculation.

The error is _____

_____

The correct calculation is _____ **[2]**

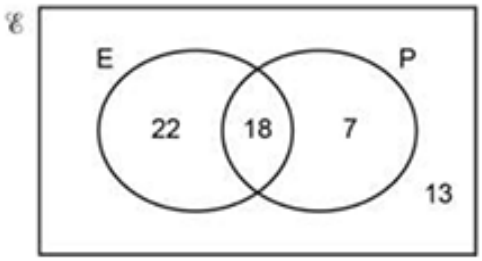
**(b).** Two students are picked at random from those who took more than 60 minutes.

Find the probability that one of them took 70 minutes or less and the other took more than 80 minutes.
You must show your working.

…… **[5]**

**19.** A salesroom sells various types of car.
Some cars are electric (E), some are petrol (P), some are both and some are neither.

The Venn diagram below shows the salesroom's stock of cars.




An electric car is picked at random.

Find the probability that the car is also petrol.

…… **[2]**

**20.** Mrs Harper has 7 different milk chocolates and 11 different plain chocolates.

Her daughter chooses one of the milk chocolates.
Her son then chooses one of the plain chocolates.
Mrs Harper then chooses one of the remaining chocolates.

Work out how many different combinations of three chocolates they can choose.

…… **[3]**

**21(a).** A phone manufacturer records the faults that are reported.
Last week, in a batch of 112 phones, 7 were reported as faulty.

Write down the relative frequency of faulty phones in this batch.

…… **[1]**

**(b).** In 2022, the manufacturer sold a total of 13 231 phones.

Work out how many of these phones the manufacturer should expect to be reported as faulty.

…….…….…… **[2]**

**22.** A college offers 31 different subjects including 8 different languages.
Students are asked to choose one subject from Option A, one subject from Option B and one subject from Option C.

Each of the 31 different subjects appears only once, either in Option A, or in Option B or in Option C.

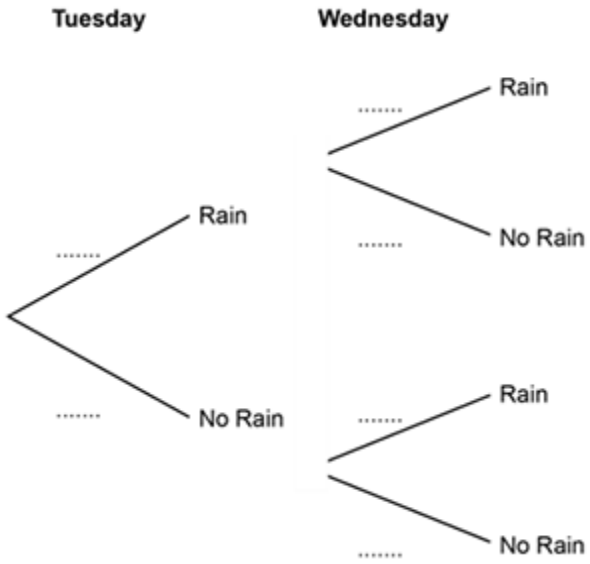
Option A : 11 subjects including 1 language
Option B : 8 subjects including 3 languages
Option C : 12 subjects including 4 languages

Work out the proportion of all the possible subject combinations that include **at least one** language.
You must show your working.

..... **[5]**

**23(a).** If it rains on a given day the probability that it will rain the next day is 0.7.
If it does **not** rain on a given day the probability that it will rain the next day is 0.25.
It rained on Monday.

Complete the tree diagram.




**[2]**

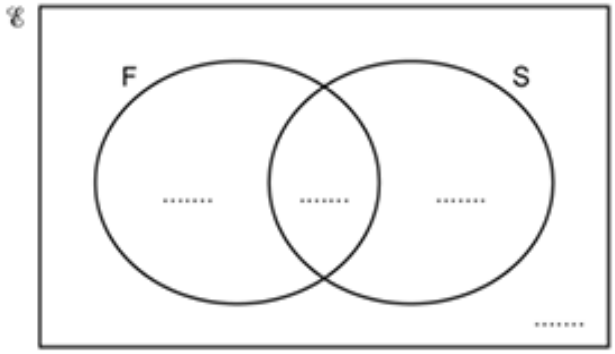
**(b).** Find the probability that it rains on Wednesday.

..... **[3]**

**24(a).** 100 people were asked whether they had visited France (F) or Spain (S).

- 65 had visited France
- 52 had visited Spain
- 6 had not visited either country.

Complete the Venn diagram.




**[3]**

**(b).** One of these 100 people is chosen at random.

i. Write down the probability that this person had visited exactly **one** of the countries.

..... **[2]**

ii. Write down the probability that this person had visited Spain given that they had also visited France.

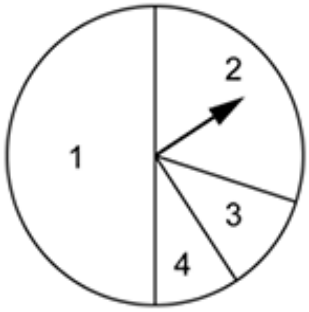
..... **[2]**

**25.** A box contains 16 counters.
The counters are either green or red in the ratio 3 : 1.
Two counters are chosen at random from the box without replacement.

Find the probability that the two counters are the same colour.
You must show your working.

..... **[5]**

**26.** A student has a spinner with sectors numbered 1, 2, 3 and 4.




The table shows the probability of each score.

| Score | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Probability | 0.5 | 0.3 | 0.1 | 0.1 |

The student spins the spinner twice.

Calculate the probability that the student gets the same score on each spin.

..... **[4]**

**27.** A security code has one letter, a number from 100–999 and three letters.
For example:

**A567CDE**

The letters I and O are not used, leaving 24 possible letters.

Show that there are approximately 300 million possible codes of this form.

**[4]**

**28(a).** A student rolls two fair four-sided dice each numbered 1, 2, 3 and 4.
They multiply the two scores together.

Complete the sample space diagram to show the possible outcomes from the dice.

Second dice

| First dice / Total | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| 1 | 1 | | | |
| 2 | | | | |
| 3 | | | | |
| 4 | | | | 16 |

**[2]**

**(b).** Find the probability that the student gets an odd total.

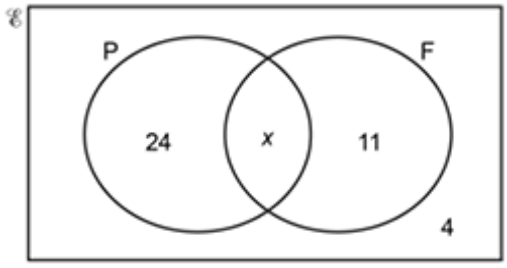
..... **[1]**

**(c).** Find the probability that the student gets a different score on each dice.

..... **[1]**

**29(a).** In a survey about snacks, some students were asked whether they like popcorn (P) and whether they like fruit (F).

The Venn diagram shows some of the results.
*x* students liked both types of snacks.




The ratio of the number of students who liked popcorn to the number who liked fruit was 3 : 2.

Work out the **total** number of students in the survey.

…… **[4]**

**(b).** One of the students is selected at random.

Find the probability that this student does **not** like fruit given that they like popcorn.

…… **[2]**

**30.** There are 15 sweets in a bag.
9 of the sweets are toffee and 6 are mint.
Jamie takes two of the sweets at random.

Work out the probability that Jamie takes one of each type of sweet.

…… **[4]**

**31(a).** Here is a restaurant's menu.

| Starter | Main | Dessert |
|---|---|---|
| Prawn Cocktail | Hunter's Chicken | Trifle |
| Duck Spring Rolls | Beef Curry | Ice Cream |
| Lamb Meatballs | Steak | Cheesecake |
| Leaf Salad (V) | Fish Pie | Chocolate Cake |
| Mushroom Soup (V) | Lasagne | Bakewell Tart |
| Dough Balls (V) | Vegetable Hot Pot (V) | Fruit Salad (V) |
| | Macaroni Cheese (V) | Cherry Pie (V) |
| | | Apple Crumble (V) |

(V) denotes vegetarian

A 3-course meal consists of one starter, one main and one dessert.

Work out how many different 3-course meals can be chosen from the menu.

…… **[2]**

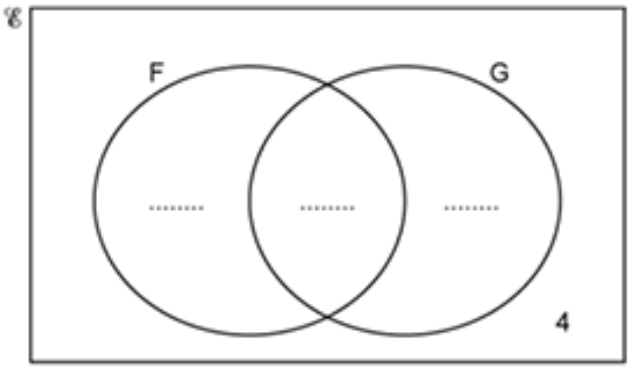
**(b).** Find the fraction of the 3-course meals which are completely vegetarian (V).

…… **[2]**

**32(a).** In a class of 32 students

- 18 study French (F)
- 15 study German (G)
- 4 do not study either subject.

Complete the Venn diagram.




**[3]**

**(b).** Two of the 32 students are chosen at random.

Calculate the probability that one of these two students studies French but not German and the other studies German but not French.
You must show your working.

..... **[5]**

**33.** In a group of 50 students, 26 own a laptop, 20 own a tablet and 10 own neither.

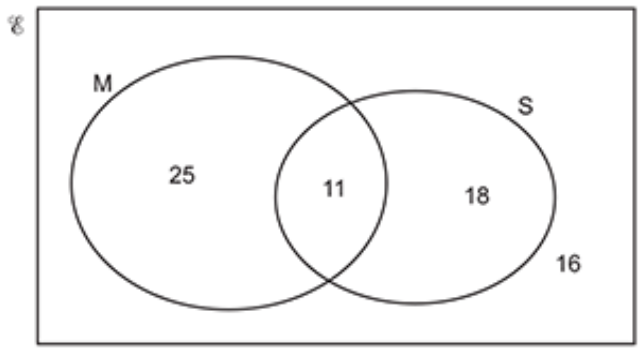
A student is chosen at random from those that own a tablet.

Find the probability that they also own a laptop.
You must show your working.

..... **[5]**

**34(a).** A cafe owner recorded information about customer orders for coffee.
They recorded whether the customer asked for milk (M) and whether the customer asked for sugar (S).

The results are shown in this Venn diagram.




One of the customers is chosen at random.

Find the probability that the customer asked for sugar.

..... **[2]**

**(b).** One of the customers is chosen at random.

Find the probability that the customer asked for sugar given that they asked for milk.

..... **[2]**

**35.** Riley has a set of cards.
Each card has a triangle or circle drawn on it and is coloured red or blue.

The table gives some information about the number of each type of card.

| | **Number of cards with a triangle** | **Number of cards with a circle** |
|---|---|---|
| **Number of blue cards** | 3 | 8 |
| **Number of red cards** | 9 | 2 |

Riley chooses three of these cards at random without replacement.
All three of these cards have a circle drawn on them.

Riley says

*The probability that two of these three cards are blue and one is red is less than* $\frac{1}{2}$.

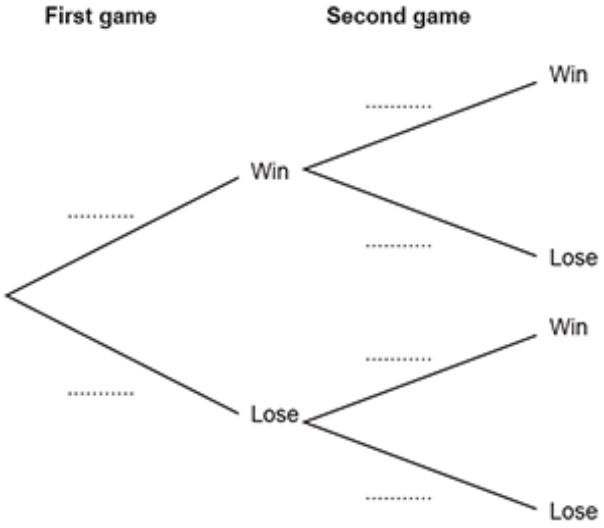
Is Riley correct?
You must show your working.

**[5]**

**36(a).** In a computer game the player can either win or lose.
A student thinks the ratio of the probability of winning to the probability of losing is 2 : 3.

The student plays two games.

Use the information to complete the tree diagram.




**[3]**

**(b).** Find the probability that the student wins at least one of the two games

..... **[3]**

**(c).** The student now thinks the ratio of the probability of winning to the probability of losing has changed to 2 : 5.

Explain the effect this change will have on your answer to the part above.

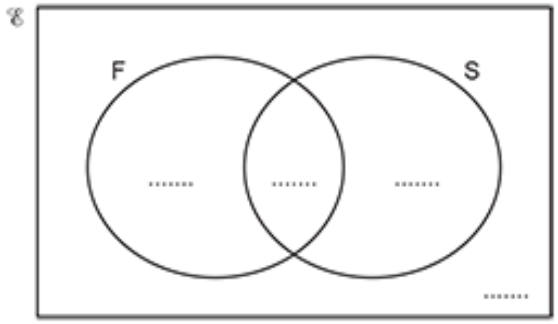
---

---**[1]**

**37(a).** 100 people were asked whether they had visited France (F) or Spain (S).

- 55 had visited France
- 60 had visited Spain
- 4 had not visited either country.

Complete the Venn diagram.




**[3]**

**(b).** One of these 100 people is chosen at random.

i. Write down the probability that this person had visited exactly **one** of the countries.

..... **[2]**

ii. Write down the probability that this person had visited France given that they had also visited Spain.

..... **[2]**

**38.** A college offers 41 different subjects including 9 different languages.
Students are asked to choose one subject from Option A, one subject from Option B and one subject from Option C.

Each of the 41 different subjects appears only once, either in Option A, or in Option B or in Option C.

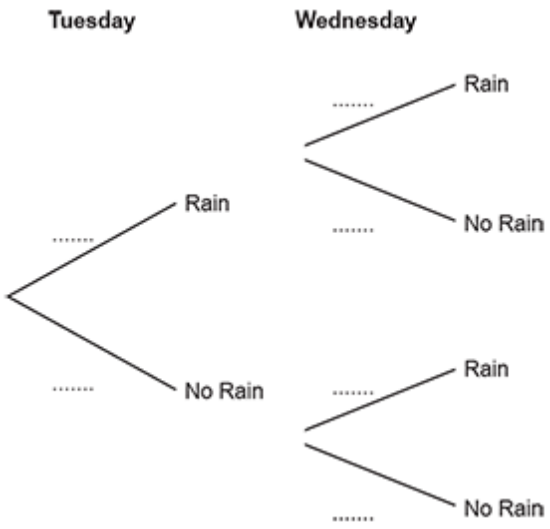
Option A : 14 subjects including 2 languages
Option B : 12 subjects including 3 languages
Option C : 15 subjects including 4 languages

Work out the proportion of all the possible subject combinations that include **at least one** language.
You must show your working.

..... **[5]**

**39(a).** If it rains on a given day the probability that it will rain the next day is 0.65.
If it does **not** rain on a given day the probability that it will rain the next day is 0.3.
It rained on Monday.

Complete the tree diagram.




**[2]**

**(b).** Find the probability that it rains on Wednesday.

..... **[3]**

**40.** A box contains 25 discs.
The discs are either blue or yellow in the ratio 4 : 1.
Two discs are chosen at random from the box without replacement.

Find the probability that the two discs are different colours.
You must show your working.

..... **[5]**

**41(a).** The time, t seconds, taken by each of 60 students to complete a puzzle is recorded.

The table shows information about these times.

| **Time (*t* seconds)** | $20 < t \leq 30$ | $30 < t \leq 40$ | $40 < t \leq 50$ | $50 < t \leq 70$ | $70 < t \leq 90$ |
|---|---|---|---|---|---|
| **Frequency** | 8 | 0 | 12 | 30 | 10 |

Two students are picked at random.
Reece works out the probability that they both took longer than 50 seconds to complete the puzzle.
Reece's working is shown below.

The number of students who took longer than 50 seconds is 30 + 10 = 40

The probability that one student took longer than 50 seconds is $\frac{40}{60} = \frac{2}{3}$

The probability they both took longer than 50 seconds is $\frac{2}{3} \times \frac{2}{3} = \frac{4}{9}$

Explain the error in their method and write the correct calculation that Reece needs to do.
You do not need to work out the answer to the calculation.

The error is _____

_____

The correct calculation is _____ **[2]**

**(b).** Two students are picked at random from those who took 50 seconds or less.

Find the probability that one of them took 30 seconds or less and the other took more than 40 seconds.
You must show your working.

..... **[5]**

**42.** Mrs Sweet has 8 different milk chocolates and 9 different plain chocolates.

Her daughter chooses one of the milk chocolates.
Her son then chooses one of the plain chocolates.
Mrs Sweet then chooses one of the remaining chocolates.

Work out how many different combinations of three chocolates they can choose.

..... **[3]**

**43(a).** A phone manufacturer records the faults that are reported.
Last week, in a batch of 96 phones, 6 were reported as faulty.

Write down the relative frequency of faulty phones in this batch.

..... **[1]**

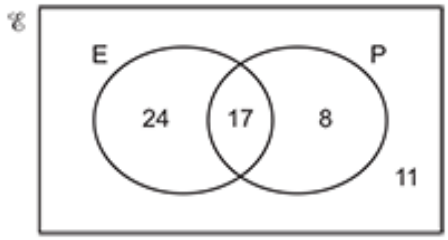
**(b).** In 2020, the manufacturer sold a total of 12 321 phones.

Work out how many of these phones the manufacturer should expect to be reported as faulty.

..... **[2]**

**44.** A salesroom sells various types of car.
Some cars are electric (E), some are petrol (P), some are both and some are neither.

The Venn diagram below shows the salesroom's stock of cars.




A petrol car is picked at random.

Find the probability that the car is also electric.

..... **[2]**

**45(a).** Here is a restaurant's menu.

| Starter | Main | Dessert |
|---|---|---|
| Prawn Cocktail | Hunter's Chicken | Trifle |
| Duck Spring Rolls | Beef Curry | Ice Cream |
| Lamb Meatballs | Steak | Cheesecake |
| Leaf Salad (V) | Fish Pie | Chocolate Cake |
| Mushroom Soup (V) | Lasagne | Bakewell Tart |
| | Egg Salad (V) | Fruit Salad (V) |
| | Vegetable Hot Pot (V) | Cherry Pie (V) |
| | Macaroni Cheese (V) | |

(V) denotes vegetarian

A 3-course meal consists of one starter, one main and one dessert.

Work out how many different 3-course meals can be chosen from the menu.

..... **[2]**

**(b).** Find the fraction of the 3-course meals which are completely vegetarian (V).

..... **[2]**

**46.** There are 15 sweets in a bag.
10 of the sweets are toffee and 5 are mint.
Reece takes two of the sweets at random.

Work out the probability that Reece takes one of each type of sweet.

..... **[4]**

**47(a).** A student rolls two fair four-sided dice each numbered 1,2, 3 and 4.
They add the two scores together.

Complete the sample space diagram to show the possible outcomes from the dice.

| | | Second dice | | | |
|---|---|---|---|---|---|
| | Total | 1 | 2 | 3 | 4 |
| First dice | 1 | 2 | | | |
| | 2 | | | | |
| | 3 | | | | |
| | 4 | | | | 8 |

**[2]**

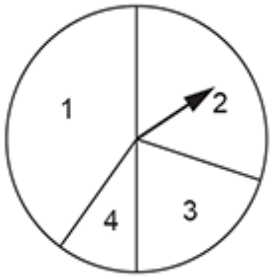
**(b).** Find the probability that the student gets an even total.

..... **[1]**

**(c).** Find the probability that the student gets the same score on each dice.

..... **[1]**

**48.** A student has a spinner with sectors numbered 1,2, 3 and 4.




The table shows the probability of each score.

| Score | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Probability | 0.4 | 0.3 | 0.2 | 0.1 |

The student spins the spinner twice.

Calculate the probability that the student gets the same score on each spin.

..... **[4]**

**49.** A car registration plate has two letters, a number from 10–99 and three letters.
For example:

**AB56 CDE**

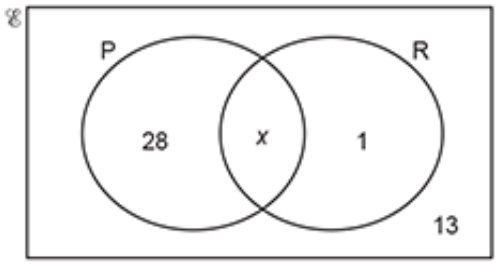
The letters I and O are not used, leaving 24 possible letters.

Show that there are approximately 720 million possible car registration plates of this form.

**[4]**

**50(a).** In a survey about music, some students were asked whether they like pop (P) and whether they like rap (R).

The Venn diagram shows some of the results.
*x* students liked both types of music.




The ratio of the number of students who liked pop to the number who liked rap was 5 : 2.

Work out the **total** number of students in the survey.

**(a)** ..... **[4]**

**(b).** One of the students is selected at random.

Find the probability that this student does **not** like rap given that they like pop.

..... **[2]**

**51(a).** Ling throws a six-sided dice 300 times.
The table shows the frequencies of their results.

Complete the table to show the relative frequencies.

| **Number on dice** | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| **Frequency** | 42 | 27 | 57 | 60 | 39 | 75 |
| **Relative frequency** | | | 0.19 | | | |

**[2]**

**(b).** Ling thinks that the dice may be biased.

i. Explain why evidence from the table could support their opinion.

**[1]**

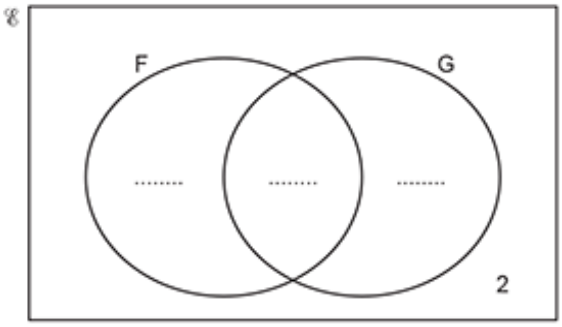
ii. Explain why the dice may, in fact, **not** be biased.

**[1]**

**52(a).** In a class of 30 students

- 17 study French (F)
- 20 study German (G)
- 2 do not study either subject.

Complete the Venn diagram.




**[3]**

**(b).** Two of the 30 students are chosen at random.

Calculate the probability that one of these two students studies French but not German and the other studies German but not French.
You must show your working.

..... **[5]**

**53.** In a group of 60 students, 40 own a smartphone, 27 own a tablet and 8 own neither.

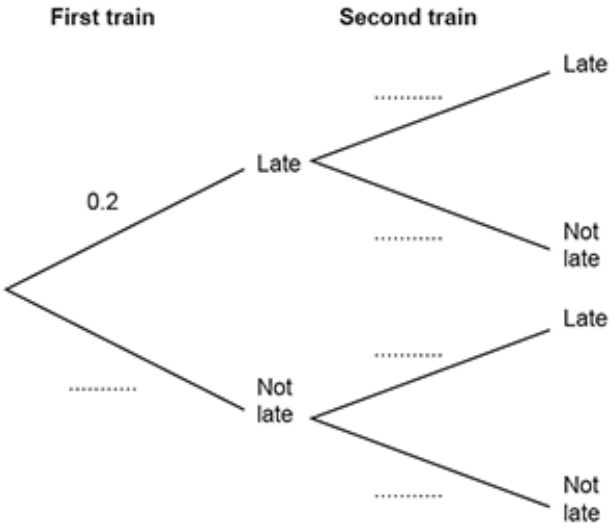
A student is chosen at random from those that own a tablet.

Find the probability that they also own a smartphone.
You must show your working.

..... **[5]**

**54(a).** Over a long period of time, it is found that the probability of a train from Bewford to London being late is 0.2.

i. One morning there are two trains from Bewford to London.
Use the information to complete the tree diagram.




**[2]**

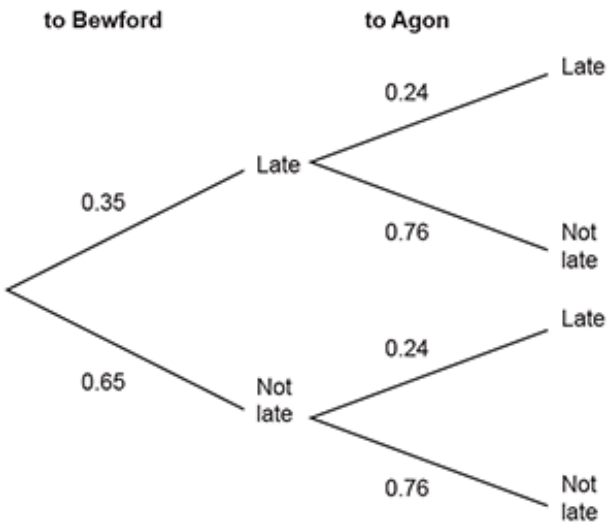
ii. Work out the probability that both trains are **not late**.

**(ii)** .....**[2]**

iii. Give a reason why the probabilities used in the tree diagram for the second train may **not** be reliable.

**[1]**

**(b).** Morgan takes a train from London to Bewford and then another train to Agon.
The tree diagram shows the probabilities of Morgan's trains being late or not late.



Morgan will **not catch** the train to Agon if the train to Bewford is late and the train to Agon is not late.

Work out the probability that Morgan will **catch** the train to Agon.

.....**[3]**

**55.** Li throws two fair four-sided dice, each numbered 1, 2, 3 and 4.
Li multiplies together the two numbers that the dice land on to produce a score.

Find the probability that Li's score is a prime number.

..... **[4]**

**END OF QUESTION PAPER**