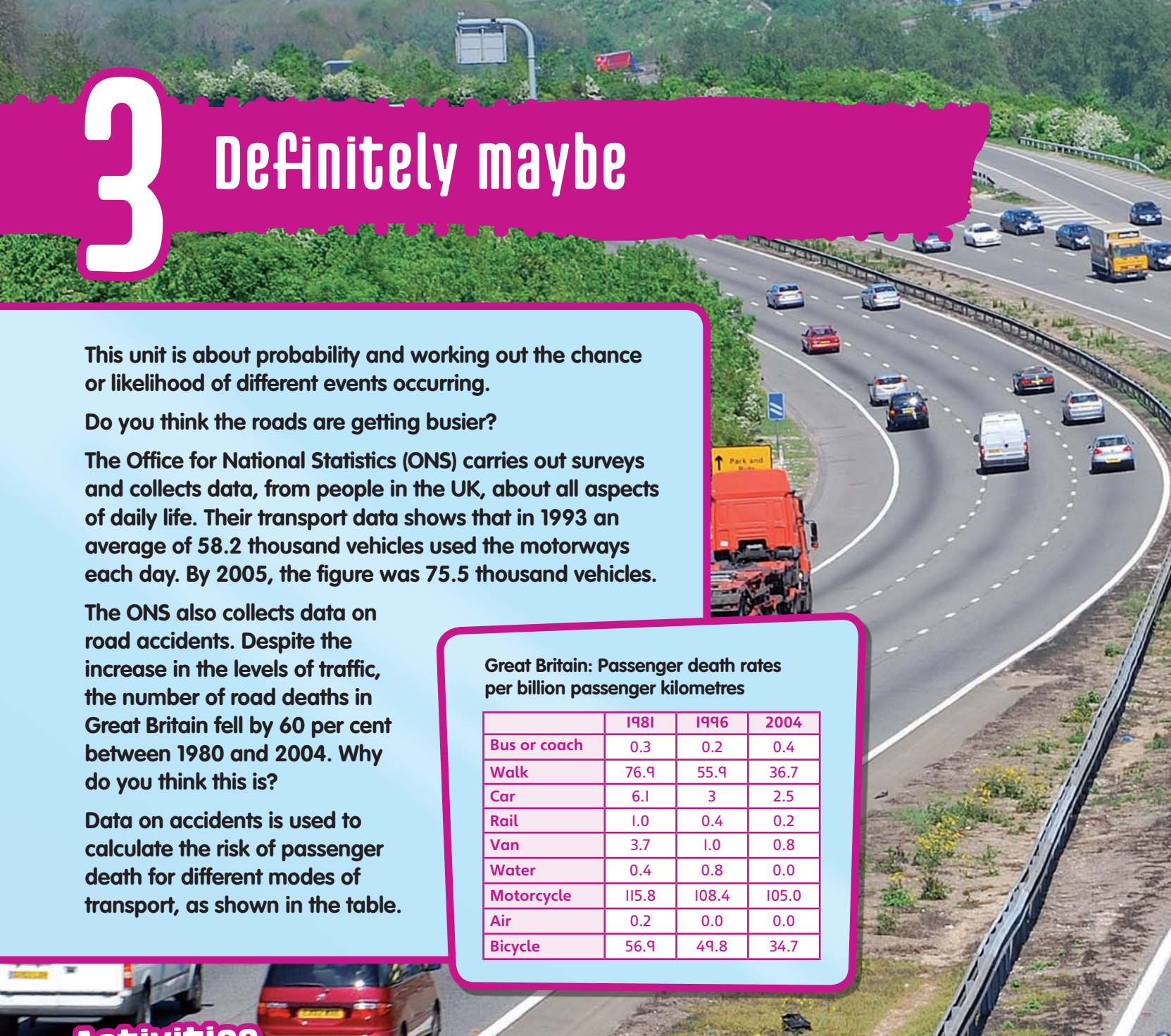
3 Definitely maybe



This unit is about probability and working out the chance or likelihood of different events occurring.

Do you think the roads are getting busier?

The Office for National Statistics (ONS) carries out surveys and collects data, from people in the UK, about all aspects of daily life. Their transport data shows that in 1993 an average of 58.2 thousand vehicles used the motorways each day. By 2005, the figure was 75.5 thousand vehicles.

The ONS also collects data on road accidents. Despite the increase in the levels of traffic, the number of road deaths in Great Britain fell by 60 per cent between 1980 and 2004. Why do you think this is?

Data on accidents is used to calculate the risk of passenger death for different modes of transport, as shown in the table.

Great Britain: Passenger death rates per billion passenger kilometres

	1981	1996	2004
Bus or coach	0.3	0.2	0.4
Walk	76.9	55.9	36.7
Car	6.1	3	2.5
Rail	1.0	0.4	0.2
Van	3.7	1.0	0.8
Water	0.4	0.8	0.0
Motorcycle	115.8	108.4	105.0
Air	0.2	0.0	0.0
Bicycle	56.9	49.8	34.7

Activities

A Look at the data in the table.

In 2004, which method of transport had the highest death rate?

Which had the highest death rates in 1981 and 1996?

Why do you think this might be? Consider factors such as age, training and vehicle design.

B Public transport is the safest option!

Use the data in the table to help you decide whether this statement is true.

Give reasons for your answer.

Before you start this unit...

1 Copy and complete the probability scale.

Level Up Maths 4-6 page 76

2 Mark these outcomes on your probability scale.

Level Up Maths 4-6 page 76

a The next baby born will be male.

b April Fool's Day will be on 2 April next year.

c It will snow in Liverpool in June.

3 Copy and complete these equivalent fractions.

Level Up Maths 4-6 page 54

a $\frac{3}{4} = \frac{6}{\square} = \frac{\square}{16}$ **b** $\frac{5}{\square} = \frac{\square}{18} = \frac{45}{54}$

4 What are the missing fractions?

Level Up Maths 4-6 page 56

a $\frac{\square}{\square} + \frac{5}{8} = 1$ **b** $1 - \frac{1}{3} = \frac{\square}{\square}$

5 Work out these in your head.

Level Up Maths 4-6 page 28

a 100 – 37 **b** 1 – 0.3

Plus digital resources

Did you know?

According to a 'trivia' website, you are more likely to be killed by a snake than in an plane crash. The website claims that you have a 1 in 3 000 000 chance of being killed by a snake, and a 1 in 6 000 000 chance of being killed in a plane crash.

3.1 What are your chances?

- Use probability words to describe the results of an experiment and the chances of something happening
- Understand that random events are unpredictable
- Use fractions to compare the chances that events will happen

Why learn this?

We need to be able to understand information about the risk of something happening.

What's the BIG idea?

- All **probabilities** have a value from 0 to 1. Level 5
- You can use a probability scale to show the outcome of an event in words or in values between 0 and 1. The probability of the **outcome** of an **event** can be described as impossible, possible, certain, even chance, likely or unlikely. Level 5
- The probability of something happpening

$$= \frac{\text{total number of successful outcomes}}{\text{total number of possible outcomes}}$$ Level 5

- You can write a probability as a fraction, a decimal or a percentage. Level 5

Did you know?

You have a 1 in 10 chance of dying from lung cancer if you are a moderate smoker and almost a 1 in 5 chance if you are a heavy smoker (more than 15 cigarettes a day).

Practice, practice, practice!

Level 5

5c I can use the probability scale

1 In a game you have to match a letter with any number containing that letter. For example, the letter 't' matches numbers 2, 3 and 8 ('**t**wo', '**t**hree' and 'eigh**t**').

a Work out and mark on a probability scale the likelihood of matching each letter with the number cards shown.

7	5	3	9	8	1

i 'i' **ii** 'e' **iii** 'x'

b What probability word best describes your chance of matching the letter 'g' with one of these numbers?

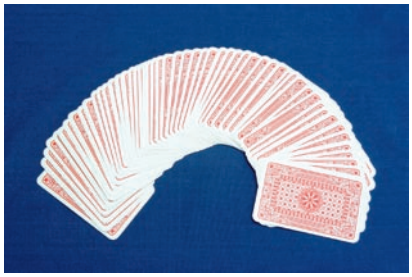
impossible	unlikely	even chance	likely	certain

5b I can explain why random events are unpredictable

2 Zoe deals 13 cards from a normal 52-card pack. They are all hearts or diamonds.

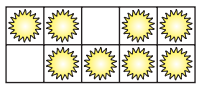
a Is it possible to deal a red card next? Explain your answer.

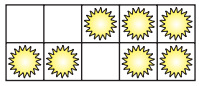
b Zoe says, 'The next card will definitely be a black card'.
Sabrina says, 'The next card is likely to be black'.
Who is correct?

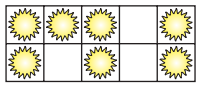


biased event fair likelihood

3 On a scratch card you win if you find a 'sun' in the first square you scratch off.
Here are the scratch cards before the suns are covered.

A 

B 

C 

a Which card gives you the greatest chance of winning?

b Design a scratch card that would give an even chance of winning.

Level 5

5a I can compare probabilities using simple fractions

4 Here are the results of a football tournament.

Round	0–0	Score draw	Win
1	2	9	5
2	2	3	3
Quarter-finals	2	0	2
Semi-finals	0	0	2
Final	0	0	1

a In which round was a 0–0 result most likely?

b Was a win more likely in the quarter-finals or the semi-finals?

Level 6

6c I can compare probabilities using fractions with the same numerator

5 Use the results table in Q4 to answer these questions.

a Was a win in Round 1 more likely than a score draw in Round 2?

b In which round was a win least likely?

6b I can compare probabilities using equivalent fractions

6 Jim has two bags.
Bag A contains 18 balls. 15 of them are red.
Bag B contains 40 balls. 32 of them are red.
Jim picks a ball at random from each bag. From which bag is he most likely to pick a red ball?

6b I can compare probabilities using decimal conversions of fractions

7 Three friends compare how many MP3 tracks they have by the band 'Wow!' and how many tracks they have in total. 34 out of Tirone's 914 tracks are by 'Wow!', Tariq has 29 out of a total of 833, and Trisha has 18 out of 547.
They each play a track at random.

a Who is most likely to play a track by 'Wow!'?

b Trisha adds another 'Wow!' track to her MP3 player. Will she now be more likely than Tariq to play a track by 'Wow!'? Explain your answer.

6a I can use probability to find the likelihood of a complex event happening

Tip
To compare probabilities given as fractions use your calculator to change them into decimals (top divided by bottom).

Now try this!

A Raise three

A game for 2 players. You need a complete suit (e.g. hearts) from a pack of cards.
Shuffle the cards and deal six cards each, face down. Place the remaining card face up on the table. Take turns to predict whether your next card will be higher, or lower, than the card in the middle. Bet 1, 2 or 3 points on the outcome, then turn up your cards. If your prediction is correct, add the points to your score – if not, subtract them. Then place your card in the middle for the other player to bet against.

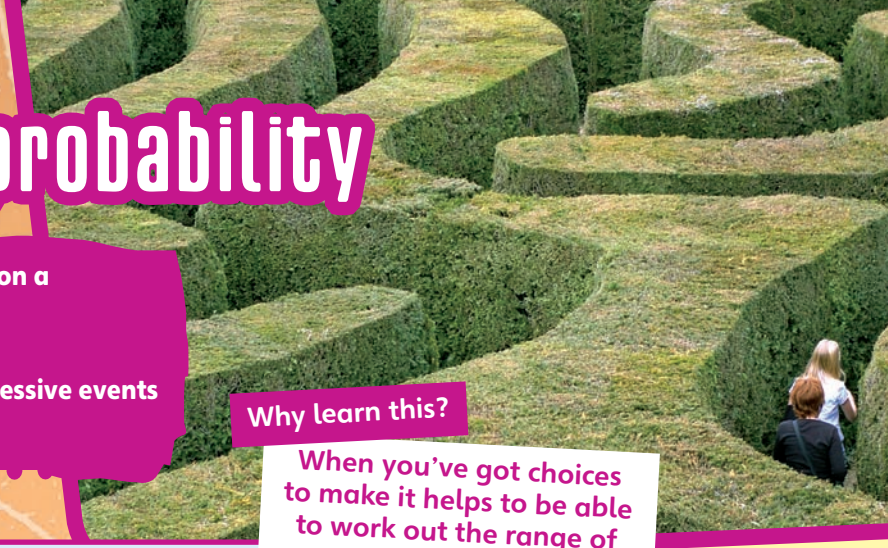
B Fraction cards

A game for two players. Each design five fraction cards, using single-digit numerators and denominators (make the numerator smaller than the denominator). Swap cards and order your partner's cards, from smallest to largest. Check with a calculator. The person with the most cards in order wins. Repeat with different sets of fractions.

outcome probability random

3.2 Representing probability

- Represent the likelihood of something happening on a probability scale
- Understand the term 'mutually exclusive'
- Identify all possible outcomes for one, or two successive events
- Use diagrams and tables to represent probability

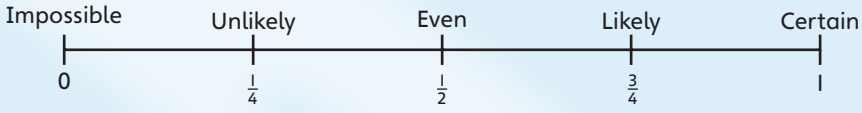


Why learn this?

When you've got choices to make it helps to be able to work out the range of options available.

What's the BIG idea?

- You can use a **probability scale** to show the **outcome** of an event.



Level 5

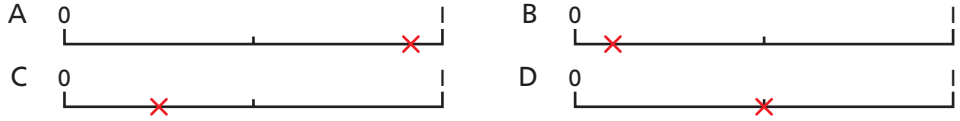
- If one **outcome** is equally as likely as another, it is possible to work out the probability of an event happening.
  For example, every ball is equally likely to be selected from a set of lottery balls numbered 1 to 49. The probability that the first ball is even is $\frac{24}{49}$. Level 5
- **Mutually exclusive** outcomes are things that cannot happen together.
  For example, the two outcomes for tossing a coin are mutually exclusive – either heads or tails Level 6
- You can use a **sample space diagram** to list all the possible outcomes of two combined events. The total number of possible outcomes is equal to the number of possible outcomes in the first event, multiplied by the number of possible outcomes in the second event. Level 6

Did you know?

You have roughly a 1 in 14 000 000 chance of winning the lottery.

Practice, practice, practice!

1 Match each cross on these probability scales with one of the probabilities.



a the probability that a number chosen at random between 1 and 100 is even

b the probability that a page opened at random in a calendar is not in your birthday month

c the probability that a number chosen at random from 1 to 20 is 1 or 8

d the probability that a season chosen at random is Spring

2 Look at this list of tracks from an album.

Hey you	Wild one	Tonight	Too right	Yeah babe	Awesome
Maybe	Never	Let's dance	Why me	Groove it	Tac-a-back

A random function is used to play a track.
What is the probability that the track will

a start with the letter 't'

b end with the letter 'e'

c have only one word in the title

d begin and end with the same letter?

Level 5

5c I can understand and use a probability scale

5b I can work out the probability of an event occurring, based on an understanding of equally likely outcomes

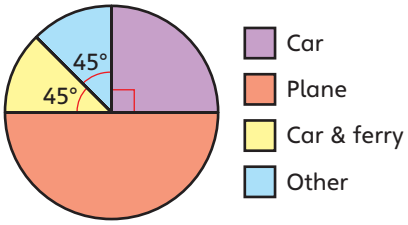
mutually exclusive outcome

Level 5

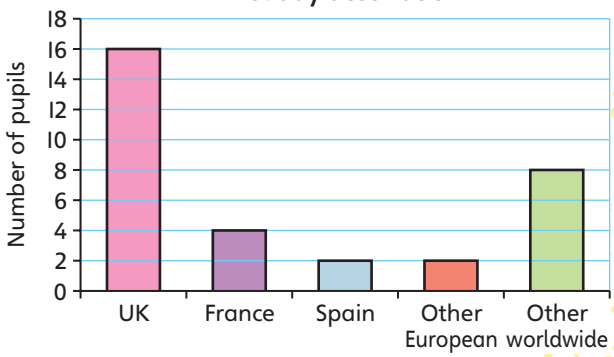
5b I can work out the probability of an event occurring, based on an understanding of equally likely outcomes

3 These charts show information collected from a group of pupils about their main holiday last year.

Transport



Holiday destination



What is the probability that a pupil picked at random

a went by plane **b** went by car and ferry **c** stayed in the UK

d went to a country in Europe other than the UK **e** went to Spain?

Level 6

6c I can identify mutually exclusive outcomes for a single event

4 Here are some ways to describe the numbers in the box.

even	under 20	product of two odd numbers	over 40	
over 50	multiple of 3	multiple of 8	cube	multiple of 7

a Find pairs of descriptions that are mutually exclusive for these numbers.

b For each pair, which of the two outcomes is more likely to occur if a number is chosen at random from the box?

99	45	3	42
16		64	

c Calculate the probability of the more likely outcome in each case.

6b I can identify all the possible outcomes for two successive events

5 In each of the final two levels of a computer game you are randomly given one of these things to help you win.

a code-breaker £1000 a banana

a Draw a sample space diagram to show all the possible outcomes.

b What is the probability that you get a banana

i in both levels **ii** in at least one level?

6 Imagine you roll a four-sided dice and a six-sided dice and add the scores together. Are you more likely to get a score greater or less than 5? Explain how you found your answer.

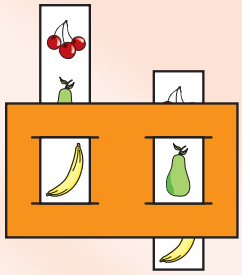
Watch out!

Order matters – getting a head first and then a tail is a different outcome from getting the tail first, then the head.

Now try this!

A Fruit machines

A game for two players. Make a 'fruit machine' like this, with the same three fruits on both strips. Player 1 secretly slides the strips to set a combination of fruits and Player 2 guesses the combination. Swap roles and repeat several times.
How likely are you to get it right?



B Race to five

A game for two players. You need an ordinary dice and a pack of cards. Take turns to roll the dice and pick a card at random. If the dice score is more than 3 and the card is not a picture card, you win 1 point. The first to five points wins. How many turns do you expect it to take to find a winner?

probability scale sample space diagram

3.3 It all adds up to 1

- If the probability of an outcome occurring is *P* then the probability of it not occurring is 1 – *P*
- Identify all the mutually exclusive outcomes of an experiment; know that the sum of the probabilities of all mutually exclusive outcomes is 1 and use this when solving problems

Why learn this?

You may want to know the chances of a card *not* being drawn if you think it will strengthen someone else's hand in poker.

What's the BIG idea?

- Probability of outcome *not* occurring = 1 – probability of outcome occurring **Level 5**
- **P(*n*)** is mathematical shorthand for 'the probability of outcome n occurring'. **Level 6**
- Probability of outcome A *or* outcome B happening
  = probability of outcome A happening + probability of outcome B happening
  P(A or B) = P(A) + P(B) **Level 6**
- When experiments are **independent**, then the outcome of the first experiment does not have any effect on the outcome of the second experiment.
  For example, if you get a head first when spinning a coin, your chance of getting a head the next time is still $\frac{1}{2}$. **Level 7**
- Probability of a combined event occurring
  = 1 – the sum of the probabilities for all other combinations **Level 7**
- A **tree diagram** helps you work out probabilities of combined events. **Level 7**

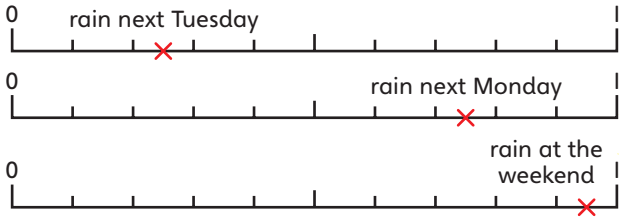
Super fact!

There is a higher chance of a baby being born a boy than a girl. In 1994 the chance of a baby being a boy was 51.35% in the UK.

Practice, practice, practice!

1 Use the probabilities on the scales to write down the probability of each of these events.

a It will rain next Monday.
b It will rain next Tuesday.
c It will rain at the weekend.
d It will not rain next Tuesday.
e It will not rain next Monday.
f It will not rain at the weekend.
g What is the sum of the answers to parts **c** and **f**?



2 Hayley wants to meet Sam and Taj. She has estimated the chances of them turning up at either her party or the youth group.
Based on her estimates, what is the probability that

a Sam goes to the youth group
b Taj doesn't go to the youth group
c Sam doesn't go to the party
d Sam doesn't go to the youth group?

	At the party	At the youth group
Sam	$\frac{2}{5}$	$\frac{1}{5}$
Taj	$\frac{1}{8}$	$\frac{5}{8}$

Level 5

5a I can work out the probability of an event not occurring

exhaustive independent

Level 6

6a I can work out the probability of an outcome occurring if I know the probabilities of all other possible outcomes

3 The school canteen has to serve a vegetable with every main meal choice. However, some vegetables seem to be served more often than others.

P(sweetcorn) = 0.15 P(tomatoes) = 0.1 P(green beans) = 0.2
P(peas) = 0.3 P(cabbage) = 0.1 P(carrots) = 0.15

What is the probability that these are served?

a tomatoes or cabbage

b any vegetable other than tomatoes or cabbage

c a vegetable that is not green

d a vegetable that doesn't begin with the letter 'c'.

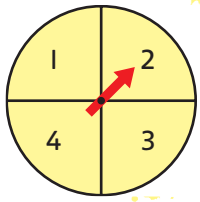
4 Here is a summary table for a week's weather predictions last winter. However, parts of the table cannot be read! Copy and complete the table.

Predicted weather	Mon	Tue	Wed	Thur	Fri	Sat	Sun
Dry	45%	60%	80%		10%		60%
Rain		40%	20%	80%	80%	65%	
Snow/sleet/hail	0%		0%	5%		10%	30%

Level 7

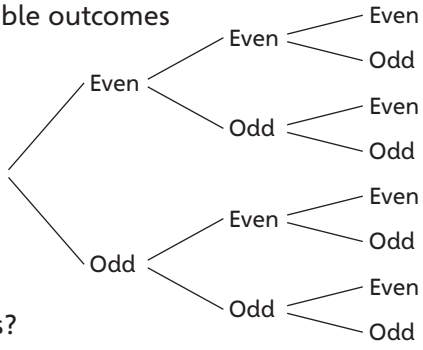
7c I can work out the probability of combined outcomes if I know the probabilities of all other possible outcomes

5 **a** Draw a tree diagram to show all the possible outcomes when the spinner is spun twice and each time it is recorded whether the number is 'a square number', or 'not a square number'.



b Sophie says there is a 50–50 chance of it landing on a square number both times. Is she correct? Explain your answer.

6 This tree diagram shows the possible outcomes when a six-sided dice is rolled three times.
What is the probability of getting an even number



a every time

b in none of the rolls

c in both the first and last rolls

d in at least one of the three rolls?

Tip
The quickest way to find the total number of outcomes for two or more successive events is to multiply the number of possible outcomes for each event together.

Now try this!

A Which card?

A game for two players. You need a pack of cards. Shuffle the cards and deal six cards each. Take turns to ask your partner probability questions about their cards (10 questions each). For example "What is the probability that if I choose one of your cards it is a picture card?" Then guess your partner's cards – you score 1 point for each correct guess.

B Menus

Work with a partner. Each design a menu with two starters, three main meals and two desserts. Secretly write down prices for every option so there is a 25% chance that the bill for three courses is exactly £15. Show each other your menus and take turns to select a three-course meal from your partner's menu. You score 1 point every time your bill is £15.
The first to score 3 points wins.

Tip
Write down your questions and answers.

P(n) for 'probability of event n' tree diagram

3.4 Experimental probability

- Know what a frequency table is and how to use it to collect data
- Use data collected in an experiment to make predictions about what might happen if the experiment is repeated
- Understand that if you carry out an experiment several times it is likely to have different outcomes each time
- Realise that predictions made from the results of an experiment become more reliable when you increase the number of times you do the experiment

Why learn this?

Experimental probability can help you predict what might happen in similar circumstances another time.

What's the BIG idea?

- A **frequency table** uses **tallying** to count the number of times a particular outcome happens. The results can be used to estimate the probability of a particular outcome if the experiment is repeated. Level 5
- Each time an experiment is repeated you can expect different outcomes. The more times you repeat an experiment, the greater the accuracy of predictions made from the results. Level 5
- The **estimated probability** of an **outcome** can be calculated after an experiment has been completed.

$$\text{Estimated probability} = \frac{\text{number of times the outcome happened}}{\text{total number of times the experiment was carried out}}$$ Level 5

- The estimated probability is the **relative frequency** of the event happening. Level 5
- Once you have worked out the probabilities for a combined experiment you can use them to estimate the number of times a combined event would be expected to occur. Level 6

Did you know?

You are three times more likely to have an accident indoors than outdoors!

Practice, practice, practice!

1 Dan has been given a biased dice and asked to investigate it.
He recorded the results of 200 rolls.

Score	1	2	3	4	5	6
Frequency	29	60	30	32	20	29

a Which number is most likely to come up?

b Which number is least likely to come up?

c He says the number 2 is likely to come up 30% of the time. Is he correct? Explain your answer.

2 A raffle is drawn every night for a week. Any ticket ending in 5 or 0 wins a prize.
Kirsty bought five tickets on Sunday and won two prizes.
On Monday, she bought 10 tickets but only won one prize.

a On Tuesday, she buys another 10 tickets.
Is she more likely to win one prize or two prizes?

b She continues to win a prize every draw.
Is she less likely to win a prize on the last night?

Level 5

5b I can estimate probabilities from experimental data collected in a frequency table

5b I can explain why an experiment may have different outcomes each time it is repeated

estimated probability experimental probability frequency

3 Pupils were asked to collect enough data to enable them to estimate the probability of an egg breaking when dropped from a height of 10 cm. Suzie broke the first egg she dropped and didn't try any more. She estimated the probability of it breaking was 100%. Tamsin bought 12 eggs and it took 96 goes before she had broken every one.

a Explain why Tamsin's estimate is likely to be more reliable than Suzie's.

b Estimate the probability of breaking an egg under these circumstances using Tamsin's data.

Level 5

5b I can explain why predictions from experimental results are better when the experiment is repeated lots of times

4 Darryl rolled two four-sided dice and calculated the difference between the numbers on the dice. He did this many times and recorded his results in a frequency table.

Difference	0	1	2	3
Tally	𝍸 𝍸 𝍸 𝍸 𝍸	𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸	𝍸 𝍸 𝍸 𝍸 𝍸 𝍸	𝍸 𝍸 ||
Frequency	25	36	27	12

a How many times did the difference equal 2?

b How many times was the experiment carried out?

c Which outcome is most likely?

d Estimate the chance of getting a difference of 2. Give your answer as a fraction.

Level 6

6c I can estimate the probabilities for the outcomes of a combined experiment from the experimental data

5 **a** Look again at Darryl's game in Q4. How many times would you expect to get a difference of 0 if you rolled the dice 1000 times?

b Imagine that a set of results shows there is 'a difference of 3' 30 times. Roughly how many times might the dice have been rolled?

6b I can use estimated probabilities to predict the outcomes of a combined experiment

6 Phil rolled two six-sided dice 80 times and added up the numbers each time. He got a total of 7 on 13 occasions.

a Use a calculator to decide whether $\frac{1}{4}$, $\frac{1}{5}$ or $\frac{1}{6}$ is the best estimate for the probability of rolling a total of 7.

b Imagine he rolled the dice 360 times.
Use your estimate to predict how many times he would expect a total of 7.

Watch out!

If an experiment has a large number of possible outcomes you will need to repeat it many times before you can calculate reliable estimates for the probabilities.

Now try this!

A Biased dice

Make a net of a cube with faces labelled 1 to 6. Stick a counter on the inside of one of the faces. Then fold and stick the net to make a biased dice. Now conduct an experiment to estimate the probability of your dice landing on each number.

Tip

Make a sample space diagram of the outcomes

B Prime or square?

A game for two players. You need two ordinary dice. Roll both dice and find the difference between the two numbers. Player 1 scores 1 point if the difference is a prime number, and Player 2 scores 1 point if it is a square number. The first to 10 points wins. Is it a fair game?

frequency table outcome relative frequency tally trial

3.5 Can you trust experimental probability?

- Review ways of identifying all possible outcomes for an experiment
- Appreciate that results of experiments in reality seldom fit in with the theory exactly
- Know that, in some situations, experimental data is the only basis for making estimates of the probability of an event
- Use theoretical probability to make games 'fair' but appreciate that a game may not be fair every time

Why learn this?

It is unwise to base a decision on a theoretical probability if any of the other outcomes could be disastrous.

What's the BIG idea?

- An experiment needs to be repeated many times to be the basis for reliable estimates of probability, so computer simulations or large databases are often used to work out **experimental probabilities**. Level 5
- The **theoretical probability** of an equally likely outcome is the predicted value.

$$\text{Theoretical probability} = \frac{\text{predicted number of successful outcomes}}{\text{total number of possible outcomes}}$$ Level 5

- Probabilities based on experimental results may be different from those predicted from theory. Level 6
- You tend to only use experimental probability if you don't understand the theory, or if it is not possible to work out theoretical probabilities. Level 6
- You can make a game '**fair**' by combining outcomes to produce events that have a theoretically equal chance of occurring. Level 6
- Experiments can provide **evidence** for an estimate of probability but theory provides the **explanation** for a probability. Level 6

Practice, practice, practice!

1 **a** Roll a dice 10 times and record whether the number is
   A equal to 3
   B greater than 3
   C less than 3.

b Calculate the probabilities for A, B and C, based on your results.

c Calculate the theoretical probabilities for A, B and C.

d How could you make your experimental probabilities closer to the theoretical probabilities?

2 A six-sided dice and a twelve-sided dice were rolled 100 times each. Experimental probabilities for rolling each number were calculated from the results. For which dice would you expect the experimental probabilities to be closest to the theoretical probabilities? Explain your answer.

Level 5

5a I can identify ways of improving the accuracy of probabilities based on experimental data

biased experimental probability evidence

3 Zack put four 50p coins in a bag. He took one out, recorded the year it was minted and put it back in the bag. He did this 40 times.

1999	2001	2001	2002	2002	1999	2001	2001	2001	1999
2002	2001	1999	2002	2001	2002	2002	1999	2002	2002
2001	1999	2001	2001	2001	2001	2001	2001	1999	2001
2002	2001	2002	1999	1999	2001	1999	2001	2001	1999

a How many coins of each date do you think there were?

b Assuming your guess is correct, what is the theoretical probability of choosing a 2002 coin?

c How many different combinations are there if he chooses a coin, puts it back and then chooses another coin?

d Is it more likely that two coins chosen in **c** are both 1999 or both 2001?

4 A five-colour spinner and a coin are used in an experiment. The spinner is spun 200 times, and the coin is spun each time. Here are the results of the trials.

	Red	Blue	Green	Grey	Brown
Head	19	22	18	21	17
Tail	21	23	20	17	22

a Use the results to calculate the experimental probability of getting 'blue' and a head. Give your answer as a percentage.

b Calculate the theoretical probability of getting 'blue' and a head as a percentage.

c How many times would you expect to get 'blue' and a head after 200 trials?

d Do you think a game played with the spinner and coin would be fair? Why?

5 A 12-sided dice has a month of the year on each side. Greg challenged Amy to play a game he invented called JAM FONDS. If he rolls two of these dice and both land with months beginning J, A or M on top he gets a point. If they both start with F, O, N, D or S Amy gets a point. Amy refused, saying the game wasn't fair.

a Explain why it isn't fair.

b Is it possible for Amy to win?

c How could the rules be changed to make it fair?

Level 6

6C I can use estimated probabilities, based on experimental data, to make predictions for more complex events

6b I can understand whether an experiment with simple outcomes is 'fair'

Watch out!

The chance of two events happening together is always much smaller than the chance of either event happening on its own.

Now try this!

A Lady luck

A game for two players. You need two ordinary dice.
Take turns to predict the total on the two dice and then roll them.
If you are correct you score 1 point. The first to 10 points wins

Tip

Use a sample space diagram to help you make your bid.

B Gamer's paradise

Use a sample space diagram to work out the theoretical probabilities when you multiply the numbers on two six-sided dice. Make up your own game rules so that choosing particular results will give you an advantage.

explanation fair theoretical probability

3.6 The best holiday ever – probably

- Use lists, two-way tables or tree diagrams to identify the number of outcomes
- Use the idea that probabilities sum to 1 to solve probability problems
- Calculate probabilities
- Know how reliable probability estimates are when they have been based on experimental data

Why learn this?

You may consider probable risks relating to health and safety before taking part in some activities.

What's the BIG idea?

- If all outcomes are not equally likely, it may be possible to **estimate** the probability of an event using experimental results. Level 5
- **Estimated probabilities** become more reliable the more times you carry out an experiment. Level 5
- **Mutually exclusive** events cannot occur at the same time. The sum of the probabilities of all mutually exclusive events add up to 1. Level 6
- The probabilities of events can be used to decide if an experiment or game is fair, or not. Level 6
- You can work out the probability for a combined event if all the other probabilities are known because the total of all the probabilities is 1. Level 7

Practice, practice, practice!

Jing was on work experience in a travel agency last week.
She left on Friday, leaving the company with some problems to sort out!

1 Jing gathered data about the punctuality of flights arriving in New York from London to use to make predictions about next year's flights.

Airline	Percentage arriving within 15 minutes of scheduled time	Total flights analysed
BOS	68.76	1005
Omega	60.18	884
Flash	44.99	3236
MiniJet	34.05	232
Zoop	22.28	543

a Why does the data for Flash give the most reliable estimate of the punctuality probability for next year?

b Which airline has the worst probability estimate for punctuality?

c Why might it not be a good idea to make assumptions about the reliability of MiniJet planes next year based on this data?

Level 5

5b I can explain why predictions from experimental results are better when the experiment is repeated lots of times

Watch out!

An estimate of a probability is not a rough guess. It should be based on experimental data.

estimate estimated probability

2 Jing left a note that said 'Mr Williams is booked on the 7.30 plane to London.' The company uses three London airports and they didn't know whether the flight was in the morning or the evening.

a How many different combinations of airport and time of day are there?

b What is the probability of choosing the correct airport if they just guess?

c What is the probability of choosing the correct time *and* airport if they guess?

3 One day Jing suggested that some of the comments in the brochure were not very positive and should be rewritten. Rewrite these statements so they sound more positive.

There is a 20% chance of rain. *There is an 80% chance it will stay dry.*

a There is a 15% chance of being delayed on the outward flight.

b There is a 7% chance of being delayed on the return flight.

c The chance of there not being enough snow to ski in February is 28%.

4 All pupils who complete a work experience placement with this travel agency are entered into a prize draw. They always give four prizes – one to a boy and another to a girl from each of the two local schools.
Explain why this may not give everybody a fair chance of winning.

5 400 customers were randomly telephoned in a follow-up satisfaction survey. Based on previous surveys

- the probability of calling someone aged 20–39 is $\frac{2}{5}$
- the probability of calling a completely satisfied customer aged over 60 is $\frac{1}{4}$
- the probability of calling a dissatisfied customer aged 40–59 is the same as that of contacting a generally satisfied customer aged 60 or over.

Copy and complete this table using the information given above.

	Completely satisfied	Generally satisfied	Dissatisfied
20–39	80	40	
40–59	60		12
60 or over			28

Level 5

5b I can work out the probability of an event occurring, based on an understanding of equally likely outcomes

5a I can work out the probability of an event not occurring

Level 6

6a I can understand whether a more complex experiment is 'fair'

Level 7

7c I can work out the probability of combined outcomes if I know the probabilities of all other possible outcomes

Now try this!

A Favourite destination

Work with a partner. You each need eight blank cards. Each choose three holiday destinations and write one on each of your cards – your favourite destination should appear most often but each destination must appear at least once. Shuffle the cards and ask your partner to pick one. Repeat this 20 times and see if your partner can guess

a your favourite destination and

b the number of cards that show that destination.

B Sum it

A game for 2 players. You need four sets of 1–4 digit cards. Player 1 shuffles the cards and deals two face down. Player 2 predicts the sum of the two cards. If correct they keep the cards, if not the cards are replaced. Swap roles and repeat. The first person with six cards wins.

mutually exclusive sum to

3.6 The best holiday ever – probably

Transport events

Ricky and Carmel are interested in the methods of transport used by people when travelling.
They have completed their research and their findings are shown in the tables below.

Table 1 Methods of transport used by children when travelling to school

	Walk	Car/van	Bus	Other
Proportion	$\frac{2}{5}$	$\frac{1}{5}$	$\frac{3}{10}$	$\frac{1}{10}$

Table 2 Methods of transport used by adults for all distances travelled in a year

	Walk	Car	Bus, coach or rail	Other
Proportion	$\frac{1}{10}$	$\frac{4}{5}$	$\frac{1}{20}$	?

1 Draw a probability scale from 0 to 1. Place the following events on your scale.
A: a child walks to school
B: a child travels by car/van to school **Level 5**

2 Mikey only travels by car to school if it is raining. If it is fine, he walks.
There is a 35% chance of rain on Wednesday. What is the probability that Mikey will walk to school on Wednesday? **Level 5**

3 Is a child more likely to travel by bus or 'other' method of transport to school? Give a full reason for your answer. **Level 5**

4 Which is the most popular method of travel to school? How can you tell? **Level 6**

5 What is the probability that a pupil travels by car or bus to school?
Give your answer as **a** a fraction and **b** a percentage. **Level 6**

6 What is the probability that Mr Wheeler will walk or drive the car to work? **Level 6**

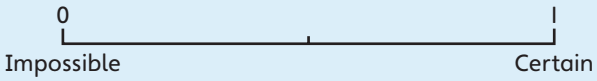
7 What is the probability that Mrs Wheeler will not travel by bus or car? **Level 6**

8 **a** What could the 'other' method of transport represent in Table 2?
b What is the probability of an adult using an 'other' method of transport?
c Is it possible to compare the tables and say that children are more likely to walk than adults? Explain your answer fully. **Level 7**

MAKE MATHS FUNCTIONAL!

The BIG ideas

- A **probability scale** is a line representing how likely something is to happen. An impossible **event** has the value 0; a certain event has the value 1. All other possible events have a value between 0 and 1. **Level 5**

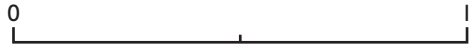


- It is easy to use fractions to compare the chances of something happening if the **denominator** of each is the same – the fraction with the largest **numerator** is most likely. For example, $\frac{7}{17}$ is more likely than $\frac{3}{17}$. **Level 5**
- Probability of an event **not** occurring = 1 – probability of event occurring. **Level 5**
- If the numerators of the fractions are the same, the event with the smallest denominator is more likely to happen. For example, $\frac{4}{18}$ is more likely to happen than $\frac{4}{23}$. **Level 6**
- If both numerators and denominators are different, you need to either find **equivalent fractions** with the same denominator, or convert the fractions into decimals to see which event is most likely. For example, $\frac{3}{8}$ is more likely than $\frac{1}{6}$ because $\frac{3}{8} = \frac{9}{24}$ is greater than $\frac{1}{6} = \frac{4}{24}$. **Level 6**
- Probability of event A or event B happening = probability of event A happening + probability of event B happening. **Level 6**
- If events are **mutually exclusive** and **exhaustive** then: Probability of any one event = 1 – probability of all other possible outcomes. **Level 6**
- It is possible to work out the probability for a complex event if all the other probabilities are known because the total should be 1. **Level 7**

Practice SATs-style questions

Level 5

Q1 A twenty-sided dice, numbered from 1 to 20, is rolled.



a Copy the probability scale. Add a cross labelled A to show the probability of the dice landing on a number that is **greater than 15**.

b Put a cross on your probability scale and label it B to show the probability of the dice landing on a number that is **more than 5**.

Q2 This information was collected in a survey about class 9E.

	Boys	Girls
Can swim	12	
Cannot swim	2	3
Total		18

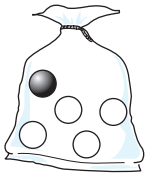
a Copy and complete the table.

b A pupil from 9E is chosen at random. What is the probability that the pupil is a boy?

c If the teacher chooses a girl instead, what is the probability that the girl cannot swim?

Level 6

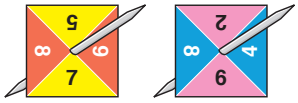
Q3 a Sharon puts 4 white balls and 1 black ball in a bag. She closes her eyes and takes a ball from the bag. What is the probability that the ball is black?



b She then adds some more black balls and says, 'The probability of getting a white ball is now two fifths'. How many black balls has she added?

Level 7

Q4 I have two fair spinners. One spinner is numbered 5, 6, 7 and 8. The other is numbered 2, 4, 6 and 8.



I spin each one and then add the numbers they land on.

a What is the probability that the total is less than 10?

b What is the probability that the total is more than 10?

c What is the probability that the total is exactly 10?

You must show your workings to explain your answers.