



Maths Level 1

Section 2

Working with fractions, decimals and percentages

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Maths Level 1

Section 1: Working with Whole Numbers

Section 2: Working with Fractions,
Decimals & Percentages

Section 3: Working with Ratio, Proportion
and Algebra

Section 4: Working with Measures

Section 5: Working with Shape &
Space

Section 6: Working with Handling
Data

Section 7: Working with Probability

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B Working with fractions

You should already know how to:

- ✓ read, write and understand common fractions
- ✓ recognise equivalent fractions.

By the end of this section you will know how to:

- read, write and compare common fractions
- use equivalent fractions to show quantities as fractions
- find fractions of whole-number quantities and measurements.

Understanding fractions

Learn the skill



A fraction is a part of a whole.

Three out of four squares are red.

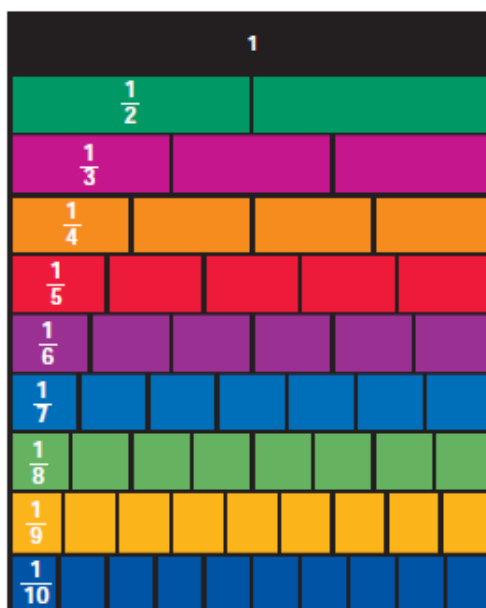


Three out of four is the same as three quarters or $\frac{3}{4}$.

red squares \rightarrow $\frac{3}{4}$ ← numerator (number on top)
total squares \rightarrow $\frac{3}{4}$ ← denominator (number on bottom)

This fraction wall shows how a **whole** can be split into **different fractions**.

1 equal part	\rightarrow $\frac{1}{1}$
2 equal parts	\rightarrow $\frac{1}{2}$
3 equal parts	\rightarrow $\frac{1}{3}$
4 equal parts	\rightarrow $\frac{1}{4}$
5 equal parts	\rightarrow $\frac{1}{5}$
6 equal parts	\rightarrow $\frac{1}{6}$
7 equal parts	\rightarrow $\frac{1}{7}$
8 equal parts	\rightarrow $\frac{1}{8}$
9 equal parts	\rightarrow $\frac{1}{9}$
10 equal parts	\rightarrow $\frac{1}{10}$



Tip

$\frac{1}{4}$ is smaller than $\frac{1}{3}$ because as you divide the whole into more parts, the fraction becomes smaller.

Reading and writing fractions

Example 1: a) write three fifths in figures
b) write $\frac{7}{10}$ in words

Answers: a three fifths = $\frac{3}{5}$ b $\frac{7}{10}$ = seven tenths

Example 2: Students can have one third off the price of rail tickets if they have a valid student railcard.

What fraction of the normal price would a student have to pay?

One third in figures is the same as $\frac{1}{3}$.



The diagram shows that, if you remove one third, there are two thirds or $\frac{2}{3}$ left.

Answer: $\frac{2}{3}$ of the normal price

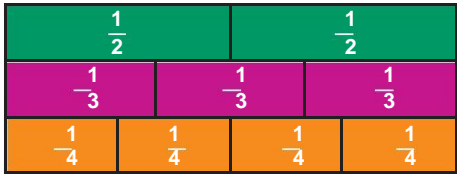
Try the skill

- Write these fractions in figures.
a one quarter b three eighths c seven tenths
- Write these fractions in words.
a $\frac{1}{8}$ b $\frac{2}{5}$ c $\frac{3}{10}$
- In a sale, all items have a half off the price. What fraction of the original price do you have to pay?
- One fifth of the Earth's atmosphere is oxygen. What fraction is not oxygen?
- A quarter of the population in a town do not vote at general elections any more. What fraction does vote at general elections?

Ordering and comparing fractions

Example 1: Write these fractions in order of size, starting with the smallest. $\frac{1}{2}, \frac{1}{4}, \frac{2}{3}, \frac{1}{3}$

Look at the fraction wall.



You can see from the fraction wall that $\frac{1}{4}$ is the smallest fraction and that $\frac{2}{3}$ is the largest.

Answer: $\frac{1}{4}, \frac{1}{3}, \frac{1}{2}, \frac{2}{3}$

Tip

You don't have to use a fraction wall to do this. It just helps you to see how the fractions compare.

Try the skill

- Write these fractions in order of size, starting with the smallest first.

a $\frac{1}{2}, \frac{1}{5}, \frac{3}{4}$ **b** $\frac{1}{3}, \frac{2}{5}, \frac{1}{4}$

- A quarter of school leavers last year went into further education and a third went into employment. Which was the more popular option for school leavers, further education or employment?
- Half the residents in a street vote for Labour and two fifths vote for the Liberal Democrats. Which is the more popular party?

Tip

For unit fractions (like $\frac{1}{2}, \frac{1}{3}, \dots$), the bigger the denominator, the smaller the fraction is.

4. Challenge question!

On a Saturday night, 3 out of every 10 television viewers prefer to watch light entertainment.

1 out of every 3 television viewers prefer to watch sport.

Which is the less preferred option?

Equivalent fractions

The fraction wall on page 28 also shows how some fractions, even though they are written differently, give the same amount.

These are **equivalent fractions**, for example:

$$\frac{1}{2} = \frac{2}{4} = \frac{3}{6} = \frac{4}{8} = \frac{5}{10}$$

$$\frac{1}{4} = \frac{2}{8}$$

$$\frac{1}{3} = \frac{2}{6} = \frac{3}{9}$$

You find **equivalent** fractions by multiplying or by dividing the numerator and denominator of a fraction by the **same number**.

Example: Simplify $\frac{12}{16}$.

Choose a number to divide into the numerator and denominator (top and bottom).

12 and 16 can both be divided by 2.

$$\begin{array}{ccc} \div 2 & & \div 2 \\ \frac{12}{16} = \frac{6}{8} & & \frac{6}{8} = \frac{3}{4} \\ \div 2 & & \div 2 \end{array}$$

Answer: $\frac{3}{4}$

Remember

Dividing bottom and top of a fraction by the same number is called **cancelling**, or **simplifying**.

Tip

You can divide top and bottom by 4:

$$\begin{array}{ccc} \div 4 & & \\ \frac{12}{16} = \frac{3}{4} & & \\ \div 4 & & \end{array}$$

1. Write the following fractions in their lowest terms.

a $\frac{6}{12}$ _____

e $\frac{24}{60}$ _____

b $\frac{15}{75}$ _____

f $\frac{18}{27}$ _____

c $\frac{21}{35}$ _____

g $\frac{36}{12}$ _____

d $\frac{40}{100}$ _____

h $\frac{64}{80}$ _____

2 Eighty out of every one hundred families in the UK own more than one television. What fraction is this?

3 Six out of ten cats prefer Kitty cat food.

a What fraction prefer Kitty cat food?

b What fraction do not prefer Kitty cat food? _____

Test tip

Even numbers can be divided by 2 and numbers that end in 0 or 5 can be divided by 5. If neither applies, try dividing by 3 or 7.

Remember

In answers, fractions should be simplified or written in their **lowest term**

Finding fractions of quantities

Learn the skill

To write one quantity as a fraction of another, put the first quantity on the top of the fraction, and the second quantity on the bottom.

Example 1: What is 5 out of 20 as a fraction?

In 5 out of 20:
5 is the first number,
20 is the second number.

$$\frac{5}{20} = \frac{1}{4}$$

$\div 5$

Answer: $\frac{1}{4}$

Tip

Always read the question carefully, to find out what you need to do.

To find a fraction of an amount or quantity, you divide:

- To find $\frac{1}{2}$ of a quantity, you divide by 2.
- To find $\frac{1}{3}$ of a quantity, you divide by 3.
- To find $\frac{1}{4}$ of something, you divide by 4.
- To find $\frac{1}{5}$ of something, you divide by 5 ... and so on.

Example 2: Find: **a** $\frac{1}{2}$ of £16 **b** $\frac{1}{3}$ of 18 cm.

a $\frac{1}{2}$ of £16 = £16 \div 2 = £8

Answer: £8

b $\frac{1}{3}$ of 18 cm = 18 cm \div 3 = 6 cm

Answer: 6 cm

- To find $\frac{2}{3}$ of a quantity:
 - find $\frac{1}{3}$ by dividing by 3
 - then find $\frac{2}{3}$ by multiplying your answer by 2.

Example 3: Find: **a** $\frac{2}{3}$ of £36 **b** $\frac{3}{4}$ of £12.

a $\frac{1}{3}$ of £36 = £36 \div 3 = £12
 $\frac{2}{3}$ of £36 = £12 \times 2 = £24

Answer: £24

b $\frac{1}{4}$ of £12 = £12 \div 4 = £3
 $\frac{3}{4}$ of £12 = £3 \times 3 = £9

Answer: £9

Remember

$$\frac{2}{3} \text{ is 2 lots of } \frac{1}{3}$$
$$= 2 \times \frac{1}{3}$$

Tip

$$\frac{3}{4} \text{ is 3 lots of } \frac{1}{4}$$
$$= 3 \times \frac{1}{4}$$

1. Write the following as fractions.

a 6 out of 20 = _____

b 14 out of 21 = _____

c 24 out of 36 = _____

d 25 out of 35 = _____

Remember

Simplify the fraction wherever possible.

2. In a safety test, a car scored 35 points out of a possible 40. Write this as a fraction in its simplest form.

3. Find the following fractions.

a $\frac{1}{2}$ of 36 kg _____

b $\frac{1}{4}$ of £32 _____

c $\frac{1}{3}$ of 27 cm _____

d $\frac{1}{5}$ of £30 _____

e $\frac{1}{6}$ of 24 m _____

f $\frac{1}{10}$ of £80 _____

g $\frac{1}{8}$ of 16 g _____

h $\frac{1}{4}$ of 28p _____

4. A train ticket normally costs £54. Matt pays for the ticket using his student railcard and is given one third off the price. How much is the discount?

5. A trainee IT worker spends one tenth of her earnings on leisure activities. If she earns £1 500 a month, how much does she spend on leisure activities each month?

6. $\frac{1}{7}$ of a concrete mix is made of cement. How much cement is needed to make 56 kg of concrete?

7. Find:

a $\frac{3}{4}$ of 16 _____

b $\frac{2}{3}$ of 48 _____

c $\frac{2}{5}$ of 45 _____

d $\frac{3}{10}$ of 60 _____

e $\frac{3}{8}$ of £48 _____

f $\frac{4}{5}$ of 45 cm _____

8. One Saturday, 300 people go to the local cinema and $\frac{2}{5}$ of them pay the discount rate. How many people pay the discount rate?

9. Of 180 employees at a factory, three-quarters are female.

a How many employees are female?

b How many employees are male?

Tip

Check your answers. The two parts should total 180.

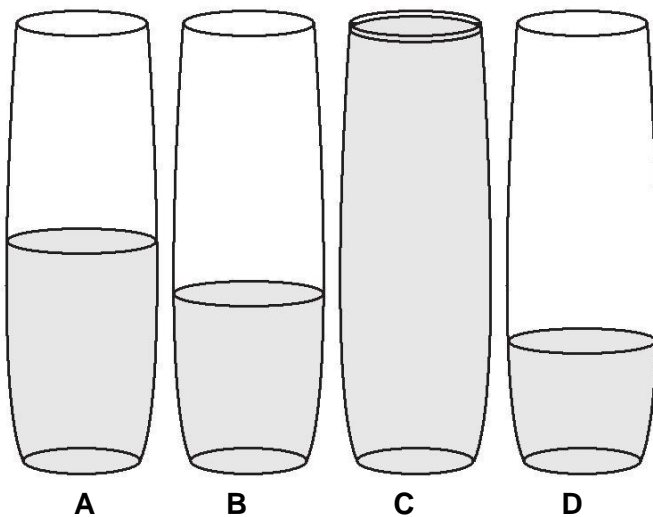
Remember what you have learned

First read this ...

- ▶ A fraction is a part of a _____.
- ▶ To write one quantity as a fraction of another, put the first quantity on the _____ of the fraction, and the second quantity on the _____.
- ▶ To find $\frac{1}{2}$ of a quantity you divide by _____.
- ▶ To find $\frac{1}{3}$ of a quantity you divide by _____.
- ▶ To find $\frac{1}{4}$ of something, you divide by _____.
- ▶ To find $\frac{1}{5}$ of something, you divide by _____.
- ▶ To find $\frac{2}{3}$ of a quantity:
 - ▶ find $\frac{1}{3}$: divide by _____.
 - ▶ find $\frac{2}{3}$: multiply by _____.

Use the skill

1. The diagram below shows four large glasses.



Which one is approximately one third full?

2. An employer receives 36 job applications and decides to interview two-thirds of the applicants.
How many applicants does she interview?

A ☐
B ☐
C ☐
D ☐

A ☐ 54
B ☐ 9
C ☐ 12
D ☐ 24

3. 1 000 raffle tickets are sold at a dance for charity. There are ten prizes to be won.
What fraction of tickets will win a prize?

- A ☐ $\frac{1}{1\ 000}$
B ☐ $\frac{1}{990}$
C ☐ $\frac{1}{100}$
D ☐ $\frac{1}{10}$

4. An optician examines 48 patients. Three-quarters of them need spectacles.
How many of the patients need spectacles?

- A ☐ 12
B ☐ 30
C ☐ 36
D ☐ 40

5. The table shows the ages of members at a local social club.

14–19	20–24
50	100

What fraction of members are aged 20–24?

Hint

Find the total number of members first.

- A ☐ $\frac{1}{3}$
B ☐ $\frac{2}{5}$
C ☐ $\frac{2}{3}$
D ☐ $\frac{4}{5}$

6. A train ticket costs £12.00. With a railcard, there is a discount of $\frac{1}{3}$ off ticket prices.
How much is the discount?

- A ☐ £36
B ☐ £3
C ☐ £8
D ☐ £4

7. Ten out of fifty runners complete a cross-country race in under an hour.
What fraction is this?

- A ☐ $\frac{1}{5}$
B ☐ $\frac{1}{4}$
C ☐ $\frac{1}{3}$
D ☐ $\frac{1}{10}$

Challenge question!

8. There are sixty adults living in one street. One third of them cycle to work in order to help the environment. Two fifths of them drive to work. The rest don't work.
How many adults use the more popular type of transport to get to work?







- A ☐ 12
B ☐ 20
C ☐ 24
D ☐ 36

C Working with decimals and money

You should already know how to:

- ✓ read, write and understand decimals
- ✓ add and subtract sums of money
- ✓ round amounts of money
- ✓ use a calculator to check answers.

By the end of this section, you will know how to:

-  order and compare decimals with up to three decimal places
-  add and subtract decimals without a calculator
-  calculate with decimals using a calculator
-  round off decimals with up to three decimal places
-  use estimation to see if answers are sensible
-  use a calculator to check answers

Understanding decimals

Learn the skill



Decimal numbers have two parts: a **whole number** part and a **part that is less than 1**.

The two parts are separated by a decimal point.

3.2 metres means 3 whole metres and 2 tenths of a metre.

whole number part part less than 1

The number of digits after the decimal point is the number of decimal places.

whole number		part less than 1			
units		tenths	hundredths	thousandths	
3	.	2			one decimal place
1	.	2	5		two decimal places
0	.	3	7	5	three decimal places

Tip

You use and write numbers as decimals every day. Common examples include measures, such as length and weight, and money.

Tip

3.456 means 3 units, 4 tenths, 5 hundredths and 6 thousandths.

You compare the size of decimal numbers by looking at the digits in each place-value position. Start with the largest place value.

Example 1: Put these lengths in order of size, starting with the largest: 2.7 m, 2.57 m, 3.7 m, 2.575 m.

Start by comparing the whole number parts first:
3 is bigger than 2 so 3.7 m is the largest length.

Next compare tenths:
7 is bigger than 5, so the next largest length is 2.7 m.

Next compare hundredths:
the hundredths are the same in 2.570 and 2.575.

So look at the thousandths:
5 is bigger than 0. So the next largest length is 2.575 m.

Answer: 3.7 m, 2.7 m, 2.575 m, 2.57 m



There are 100 pence in every pound.

Example 2: Write £2.05 in pence.

£2.05 is $2 \times 100p + 5p = 205p$

Answer: 205p

Tip

Use a place-value table. Put in zeros to line up the numbers.

U	.	t	h	th
2	.	7	0	0
2	.	5	7	0
3	.	7	0	0
2	.	5	7	5

Tip

Never use 'p' with the £ sign.

1. Put these lengths in order of size, starting with the largest. **a** 3.22 m, 3.2 m, 2.3 m, 3.23 m

b 10.7 cm, 10.07 cm, 10.777 cm, 10.707 cm, 10.007

cm **c** 5.30 km, 3.55 km, 3.505 km, 5.55 km, 5.305 km

2. Write these sums of money in order, starting with the smallest.

a £0.02, £2.22, £2.20, £0.22

b £3.33, £3.03, £33.30, £0.33, £30.03

c £15.17, £17.05, £17.15, £15.10, £15.07

3. Write these amounts in pence.

a £3.50

b £0.65

c £0.03

4. Write these amounts in pounds.

a 555p

b 20p

c 5p

Calculating with decimals

Learn the skill



adding and subtracting decimals without a calculator

Example 1: Bronwen runs 5.4 km on Friday, 4.69 km on Saturday and 11.85 km on Sunday. How far does she run, in total, from Friday to Sunday?

Write the numbers with the decimal points lined up.

Add the columns, from right to left, in the usual way.

	5	.	4	0	
	4	.	6	9	+
1	1	.	8	5	
2	1	.	9	4	

Write 0 here, to help add the digits in columns.

Answer: 21.94 km

Example 2: An empty suitcase weighs 1.92 kg. When packed, it weighs 6.2 kg. How much do the contents of the suitcase weigh?

Subtract the weight of the empty suitcase from the weight of the packed suitcase.

Write the numbers with the decimal points lined up.

Subtract in columns, from right to left, in the usual way.

6	.	2	0	
1	.	9	2	-
4	.	2	8	

Write 0 here, to show you are subtracting from the final zero.

Answer: 4.28 kg

For some people, thinking of decimals as money can make adding and subtracting decimals easier to deal with. This example demonstrates how this can work.

Example 3: A wall in Emma's bathroom is 3.2 metres long. She wishes to position a bath along this wall.

If the bath is 1.85 metres long, how much wall space is left?

Think of 3.2m as £3.20 and 1.85m as £1.85.

Count up from £1.85 to make £3.20

e.g. £1.85 counting up to £2.00 gives

£0.15 £2.00 to £3.00 gives £1.00

£3.00 to £3.20 gives £0.20

£0.15 + £1.00 + £0.20 = £1.35 Change this back to metres.

Answer: 1.35 metres

Tip

In total usually means 'add'.

Tip

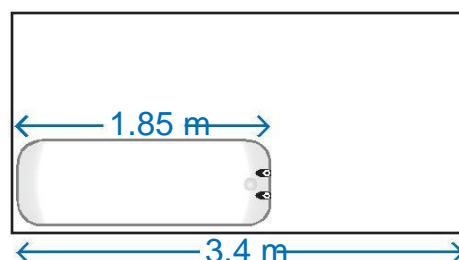
Get into the habit of checking to see if your answer makes sense. Add the whole number parts: $5 + 4 + 11 = 20$.

Tip

Use any method of subtraction you prefer, for example, 6.2 subtract 2 then add 0.08.

Remember

You don't have to subtract in problems like this using 'counting up'. There are many methods to add and subtract. Choose a method which suits you best.



Try the skill

Work out the answers using your preferred methods.
Do not use a calculator.

1. Work out:

a $4.23 + 5.66$ _____ **b** $£4.69 + £5.98$ _____
c $8.45 - 4.07$ _____ **d** $4.5 - 3.22$ _____

2. Ring the correct answer.

a $6.7 + 0.88$ **A** 6.95 **B** 7.58
b $£6.67 - £5.09$ **A** £1.58 **B** £0.77

3. One piece of rope is 66.4 m long and another is 98.7 m.
What is the combined length of the two pieces of rope?

4. Tim runs 100 metres in 12.38 seconds. Rob runs the same distance in 10.8 seconds. What is the difference between their times?

5. Ben and Nicky are travelling around the world.

On Monday, they drove 502km, on Tuesday they walked for 0.34km and on Wednesday they cycled for 10.5km. How far did they travel in total from Monday to Wednesday?



Using a calculator to calculate with decimals

Example 1: Drinks at a party cost £1.80 each.

If 250 drinks are bought, use a calculator to work out how much money this will raise.

You need to **multiply** to solve this problem.

Key into your calculator in $\boxed{1} \boxed{.} \boxed{8} \boxed{\times} \boxed{2} \boxed{5} \boxed{0} \boxed{=}$

Answer: £450

Tip

1.8 has the same value as 1.80
If you want to key in £1.80 on a calculator, just key in

$\boxed{1} \boxed{.} \boxed{8} \boxed{0} \boxed{=}$

Example 2: Winnie purchases a coach ticket normally costing £91.80.

She gets a third off the price because she is a senior citizen. How much does she pay?

You need to find two thirds of £91.80. You can do this by dividing 91.8 by 3 and then multiplying the answer by 2.

Key into your calculator $\boxed{9} \boxed{1} \boxed{.} \boxed{8} \boxed{\div} \boxed{3} \boxed{\times} \boxed{2} \boxed{=}$

The display will show **61.2**

Answer: Winnie pays £61.20

Tip

Some students may prefer to find a third of 91.80 and then subtract this answer from £91.80. Do it whichever way feels comfortable to you.

Try the skill

Use a calculator to answer the questions.

1. A magazine article recommends everyone to drink 2.5 litres of water a day. How many litres of water is this in a week?

2. Six friends shared the cost of a meal. The bill came to £78.12. How much did they each pay?

3. Tariq paid £436.80 for gas in a year. He paid in twelve equal monthly instalments. How much did he pay for gas each month?

4. The price of a train ticket that normally costs £8.31 is reduced by $\frac{1}{3}$ in a 'summer special' offer. How much is the discount?

5. A woman earns £344.80 per week. She spends $\frac{3}{4}$ of it on rent and food. How much does she spend on rent and food?

6. A shop sells cans of drink for 52p each. Thomas buys seven cans and pays for them with a £5 note. What change should he get?

7. An electricity company charges £12.50 each month for supplying the electricity and £0.12 for every unit of electricity used. Bill uses 250 units of electricity in one month. How much does Bill pay for the electricity he used?

8. Challenge question!

The normal price of fuel is 101.6p per litre. Jill has a voucher for '2p off each litre of fuel'. She buys 35 litres of fuel and also selects a bag of chocolate éclairs at the checkout.

If the éclairs cost £1.49 how much does she pay in total?

Rounding decimal amounts

Learn the skill

You can round decimal numbers to the **nearest whole number**, **nearest tenth**, or **nearest hundredth**.

To round a decimal number to the nearest whole number, look at the digit one place to the right of the decimal point (i.e. the digit in the *tenths* position):



If this number is 5 or more, increase the unit digit by 1.



If this number is less than 5, leave the unit digit as it is.

Example 1: Round each number to the nearest whole number: **a** 3.4 **b** 8.54

a The digit in the tenth position is 4, so leave the 3 as it is.

Answer: 3

b The digit in the tenth position is 5, so you must add 1 to the 8.

Answer: 9

To round a decimal number to the nearest tenth, look at the digit two places to the right of the decimal point (i.e. the digit in the *hundredths* position):



If this number is 5 or more, increase the tenth digit by 1.



If this number is less than 5, leave the tenth digit as it is.

Example 2: Round each number to one decimal place: **a** 4.65 **b** 56.982

a the digit in the hundredths position is 5, so add 1 to the digit in the tenth column.
 $6 + 1 = 7$.

Answer: 4.7

b the digit in the hundredths position is 8, so add 1 to the 9.
 $9 + 1 = 10$, so 56.9 becomes 57.0

Answer: 57.0

You can round numbers in calculations to **estimate** answers.

Example 3: A receptionist is paid £6.20 per hour. She works for 39 hours a week. What calculation could you do to estimate her total pay for the week?

First, round the numbers: £6.20 to £6 and 39 to 40

Next, multiply: $£6 \times 40 = £240$

Answer: £240

Remember

Rounding to the nearest tenth is the same as rounding to one decimal place.

Rounding to the nearest hundredth is the same as rounding to two decimal places.

Tip

When you round numbers to one decimal place, your answer should only have one digit after the decimal point.

Tip

You must write 57.0 and not just 57 to show that you have rounded off 56.982 to one decimal place.

Try the skill

1. Round these decimal numbers to the nearest whole number.

a 7.6

b 12.89

c 6.567

2. A vet weighs a dog and finds it weighs 26.7 kilograms. What is the dog's weight, to the nearest kilogram?

3. A householder reads her electricity meter: 2395.56
What is the reading, to the nearest whole number?

4. An office assistant uses his calculator to work out $500 \div 37$. The display on his calculator shows: 13.513513
Round the answer to the nearest whole number.

5. Round these decimal numbers to the nearest tenth.

a 5.63

b 12.856

c 6.899

6. A measuring jug contains 1.872 litres of lemonade. What is the volume of lemonade, to the nearest tenth of a litre?

7. Round these amounts to the nearest 10p.

a £24.45

b 15.63

c £7.99

8. Round these decimal numbers to the nearest hundredth.

a 6.375

b 0.403

c 23.498

9. A parcel waiting for delivery weighs 3.455 kg. Round this weight to two decimal places.

10. A man who earns £7.10 per hour works for 19 hours. What calculation can you do to estimate his pay?

11. Eleven people went out to dinner. Each meal cost £9.75. What calculation can they do to estimate the total bill?

Tip

10p = £0.10

Remember

The digit you need to consider is the digit in the thousandths position, i.e. the digit three places to the right of the decimal point.

Estimating and checking answers

Learn the skill



Checking that answers are sensible

Example 1: Georgia has £44.45 in her purse. She spends £8.95 on a CD. How much does she have left?

checking using estimation

Estimate each value in the question by rounding it off.

£44.45 **is roughly** £44 (rounding off to the nearest pound).

£8.50 **is roughly** £10 (rounding to the nearest ten pounds).

To round £8.50 to the nearest £10 in this case is close enough for the purpose of estimating.

£44 - £10 = **£34. This is your estimated answer.**

Is your answer close to £34?

Actual answer £44.45 - £8.95 = £35.50. This is close to £34 so it is likely you are correct.

checking using a calculator

Key into your calculator $\boxed{4}\boxed{4}\boxed{.}\boxed{4}\boxed{5}\boxed{-}\boxed{8}\boxed{.}\boxed{9}\boxed{5}\boxed{=}$

The display on your calculator reads **35.5**

Answer: £35.50

Tip

1. It's a good idea to take the time to ask yourself what sort of answer you are expecting.
2. You can round values off as you want; there are no hard and fast rules!
3. If your estimated answer had been e.g. £3.40 or £340, you have made a mistake. £3.40 and £340 are nowhere near £35.50!

Remember

1. All you are trying to do here is to see if your actual answer is close to your estimated answer.
2. If the question is about money, .5 on a calculator display means 50 pence or £0.50.

A student has completed the exercise below. Check to see if his answers are correct using the method given. If you think he is wrong, write down your reasons why.

1. The menu for a café is shown. Simon buys two cans of drink and an ice-cream. How much does it cost him?

Student answer: £2.04

Check using calculator

2. A woman has £420.65 in her bank account. She pays £182 into the account and then writes a cheque from her bank account for £83.67. What is her new balance?

Student answer: £518.98

Check using estimation

3. Belle works in a music shop and earns £7.80 an hour. One week she is paid £280.80. How many hours did she work?

Student answer: 36

Check using estimation

Menu

Refreshments:

Cans of cold drink	47p
Ice-cream	£1.20
Popcorn	99p

Remember what you have learned

Use the skill

1. Juan writes a cheque for two hundred and two pounds and two pence.

How does he write this amount in figures?

- A £202.02
- B £202.2
- C £220.20
- D £220.02

2. A customer buys five packets of biscuits and two cakes in the supermarket. *Use a calculator to work out this question.*



How much does he pay in total?

- A ☐ £6.93
- B ☐ £9.03
- C ☐ £11.40
- D ☐ £15.96

3. A householder reads her electricity meter.

45675.54

What is the reading, to the nearest whole number?

- A ☐ 45 680
- B ☐ 45 675
- C ☐ 45 676
- D ☐ 45 670

4. In a supermarket, a man picks up shopping that totals £35.17. As he has only £35 in vouchers, he decides to put back a jar of coffee costing £3.49.

How much is the new total?

- A ☐ £30.68
- B ☐ £31.68
- C ☐ £31.58
- D ☐ £31.78

5. An assistant at a garden centre is paid £7.90 per hour. She works 40 hours per week.

Which of these is the closest estimate of her total pay for the week?

- A ☐ £7 × 30
- B ☐ £8 × 30
- C ☐ £7 × 40
- D ☐ £8 × 40

D Working with percentages

You should already know how to:

- ✓ recognise and use common equivalent fractions
- ✓ read, write and understand decimals.

By the end of this section you will know how to:

- recognise equivalences between common fractions, percentages and decimals
- calculate percentages of quantities or measures
- calculate percentage increases and decreases
- express one quantity as a percentage of another.

Understanding percentage

Learn the skill

A percentage is the number of parts per hundred. 2% is 2 parts per hundred.

A percentage is the numerator of a fraction, when the denominator is 100: 20% means 20 out of 100.

The grid shows 100 equal squares.

50 squares (half of the grid) are coloured blue.

$\frac{50}{100}$ is 50%.

▶ $\frac{50}{100} = \frac{1}{2}$, so $50\% = \frac{1}{2}$.

25 squares (one quarter of the grid) are coloured red.

$\frac{25}{100}$ is 25%.

▶ $\frac{25}{100} = \frac{1}{4}$, so $25\% = \frac{1}{4}$.

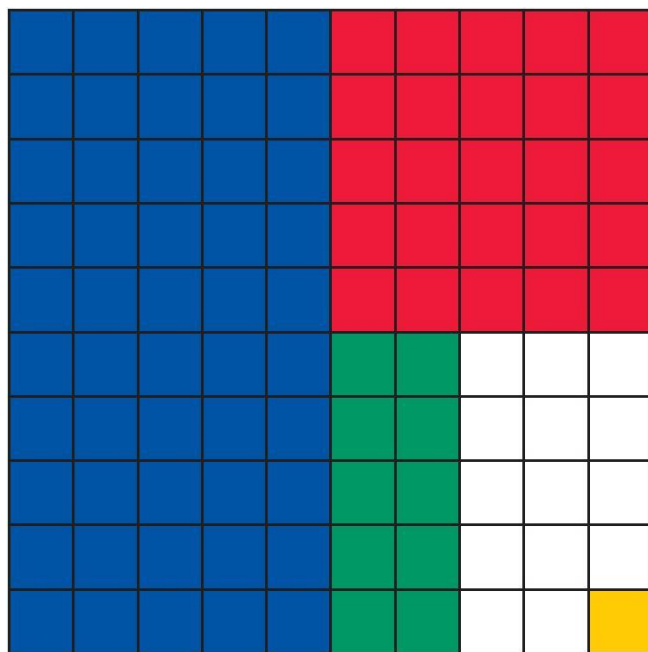
10 squares (one tenth of the grid) are coloured green.

$\frac{10}{100}$ is 10%.

▶ $\frac{10}{100} = \frac{1}{10}$, so $10\% = \frac{1}{10}$.

1 square (one hundredth of the grid) is coloured yellow.

$\frac{1}{100}$ is 1%.



A percentage can always be **written as a fraction** with the **denominator equalling 100**. This is because a percentage is a number out of 100. For example, 5% is the same as $\frac{5}{100}$. This can be simplified to $\frac{1}{20}$ by dividing top and bottom by 5. $\frac{5}{100}$ also means $5 \div 100$ which equals 0.05. 5% also equals 0.05. A percentage can always be **written as a decimal** by **dividing it by 100**.

Example 1: Write 20% as: **a** a decimal **b** a fraction.

a $20\% = \frac{20}{100} = 20 \div 100 = 0.2$

Answer: 0.2

b $20\% = \frac{20}{100} = \frac{2}{10} = \frac{1}{5}$

Answer: $\frac{1}{5}$

You divide a *percentage* by 100 to change it into a *decimal*. So, do the opposite to change a *decimal* into a *percentage*.

To change a decimal or a fraction into a percentage, **multiply it by 100**.

Example 2: Write $\frac{2}{5}$ as a percentage.

$\frac{2}{5} \times 100 = \frac{200}{5} = 200 \div 5 = 40$

Answer: 40%

Tip

To simplify a fraction to its lowest terms, divide the numerator and denominator by the same number.

Tip

You can also say:

20% is double 10%

10% = 0.1

$2 \times 0.1 = 0.2$

1. Write 75% as:

a a decimal _____ **b** a fraction _____

2. Work out the missing decimals and fractions and write them in the table.

	Percentage	Fraction	Decimal
a	50%	$\frac{1}{2}$	
b	25%		
c	10%		0.1

	Percentage	Fraction	Decimal
d	30%		
e	40%		
f	5%		

Tip

75% is the same as 25% plus 50%.

3. Match each percentage to its equivalent fraction or decimal.

50%	30%	75%	60%	3%	80%
0.3	0.03	$\frac{4}{5}$	$\frac{1}{2}$	$\frac{3}{5}$	$\frac{3}{4}$

Percentages of quantities

Learn the skill

50% is a half so, to find 50% of an amount, you halve it or divide by 2.

Example 1: What is 50% of 30?

$$50\% = \frac{1}{2}$$

$$\frac{1}{2} \text{ of } 30 = 15$$

Answer: 15

Example 2: What is 50% of £24?

$$\frac{1}{2} \text{ of } £24 = £12$$

Answer: £12



10% = $\frac{1}{10}$ so, to find 10% of an amount, you can divide the amount by 10.

10% of £1.00 is $£1.00 \div 10 = £0.10$.

Example 3: What is 20% of £6.40?

To find 10% of an amount, divide by

$$10: £6.40 \div 10 = £0.64$$

This does not mean that, to find 20% of an amount, you divide the amount by 20! 10% is a special case. 20% is double 10%: $2 \times £0.64 = £1.28$

Answer: £1.28

Example 4: Find 5% of 250 ml.

$$10\% \text{ of } 250 \text{ ml} = 25 \text{ ml}$$

$$5\% \text{ is half of } 10\%, \text{ so } 25 \text{ ml} \div 2 = 12.5 \text{ ml}$$

Answer: 12.5 ml

Example 5: 25 624 people went to a pop concert. 50% of them bought their ticket online. How many people bought their tickets online?

First, work out what the question is asking for:

$$50\% \text{ of } 25\,624 = 25\,624 \div 2 = 12\,812$$

Answer: 12 812 people

Example 6: A terraced house was worth £120 000 five years ago. It is now worth 75% more than this amount. By how much has the value of the house increased?

First, work out what the question is asking for: 75% of £120 000

$$50\% \text{ of } £120\,000 = £60\,000 \quad 25\% \text{ of } £120\,000 = £30\,000$$

$$75\% = 50\% + 25\% = £60\,000 + £30\,000$$

Answer: £90 000

Tip

Use 10% to find other amounts:

$$20\% = 10\% \times 2.$$

Find 10% then multiply by 2.

$$5\% = 10\% \div 2.$$

Find 10% then divide by 2.

Remember

To find half of an amount, you divide by 2.

Remember

$$75\% = 50\% + 25\%$$

Try the skill

1. Circle the methods you could use to calculate 25% of £6.40.

a halve £6.40, then halve the answer
b divide £6.40 by 25
c divide £6.40 by four
d multiply £6.40 by 25, then divide by 100
e multiply £6.40 by 100, then divide by 25
f divide £6.40 by ten to find 10%
halve this answer to find 5%
then add 10%, 10% and 5%

2. Find the following amounts.

a 50% of 48

b 50% of 74

c 25% of 16

d 75% of 120

3. To buy a car costing £2 400, a woman has to pay a deposit of 25%. How much is this?
- _____

4. A house that was worth £59 000 three years ago has now increased its value by 50%. How much is this increase?
- _____

5. Find the following amounts.

a 10% of £40

b 10% of £66

c 20% of £8

d 20% of £3.20

e 5% of £60

f 5% of £900

g 30% of £4

h 20% of £6.20

6. Amanda earns £285 a week. This is due to increase by 10%. How much is the increase?
- _____

7. The price of a DVD player is reduced in a sale by 20%. If it normally costs £90, what is the discount?
- _____

Remember

$$\begin{array}{l} 50\% = \frac{1}{2} \\ 25\% = \frac{1}{4} \\ 75\% = \frac{3}{4} \end{array}$$

One quantity as a percentage of another

Learn the skill

You need to be able to find one quantity as a percentage of another.



To find one quantity as a percentage of another:

▶ divide the first quantity by the second: $\frac{\text{first}}{\text{second}}$

▶ then multiply the answer by 100: $\frac{\text{first}}{\text{second}} \times 100$

It helps if you simplify the fraction $\frac{\text{first}}{\text{second}}$

Example 1: What is 5 as a percentage of 20?

First, divide 5 by 20: $\frac{5}{20}$ Simplify: $\frac{5}{20} = \frac{1}{4}$

Then multiply the answer by 100: $\frac{1}{4} \times 100 = 25$

Answer: 25%

Example 2: Out of 80 guests staying at a hotel, 60 had the full cooked breakfast. What percentage of guests had the full cooked breakfast?

First, divide 60 by 80: $\frac{60}{80}$ Simplify: $\frac{60}{80} = \frac{3}{4}$

$\frac{3}{4} \times 100 = 75$

Answer: 75%

Example 3: A company made £4 million profit in 2004 and £2 million profit in 2005. What was the profit in 2005 as a percentage of the profit in 2004?

First, divide £2 000 000 by £4 000 000: $\frac{£2\,000\,000}{£4\,000\,000}$

Simplify: $\frac{£2\,000\,000}{£4\,000\,000} = \frac{1}{2}$

$\frac{1}{2} \times 100 = 50$

Answer: 50%

Example 4: A group of friends spent £250 on organising a shared birthday party. They spent £100 of this on drinks. What percentage of the total did they spend on drinks?

First, divide £100 by £250: $\frac{£100}{£250}$ Simplify: $\frac{£100}{£250} = \frac{2}{5}$

$\frac{2}{5} \times 100 = 40$

Answer: 40%

Tip

If you see the phrase 'as a percentage' in a question, write the amount before it on top and the number following it underneath, then multiply by 100.

Remember

To find $\frac{3}{4}$, divide by 4 then multiply by 3.

1. What is 15 as a percentage of 60?

2. What is 16 as a percentage of 80?

3. What is 8 as a percentage of 160?

4. What is 15 as a percentage of 50?

5. What is 36 as a percentage of 180?

6. What is 20 as a percentage of 400?

7. What is 12 kg as a percentage of 60 kg?

8. A garage MOT tested 40 cars in one week. 36 cars passed the test. What percentage passed?

9. Mrs Stamper's weekly pay is £350. She receives a bonus of £70. Express the bonus as a percentage of her weekly pay.

10. The normal price of a two-week package holiday is advertised as £800. As a special offer, it is £200 cheaper. Express the saving as a percentage of the normal cost.

11. In a street there are 80 residents. 24 of them went to a meeting to discuss a proposed skate park. What percentage of the residents went to the meeting?

12. A company has 300 workers. 27 people work in the sales department. What percentage of the company work in the sales department?

13. A city has 15 leisure centres. Twelve of them will be closed on New Year's Day. What percentage of the leisure centres will be closed on New Year's Day?

Percentage increase and decrease

Learn the skill

A service charge added on to a restaurant bill may be expressed as a **percentage increase**.

You increase an amount by adding on.



If an amount is **increased**, the new amount is **more than 100%**.

Example 1: Increase 80 by 10%.

First find 10% of 80: $10\% \text{ of } 80 = 8$

The question is about percentage increase, so add: $80 + 8$

Answer: 88

You can do the increase in one calculation:

$$100\% + 10\% = 110\%$$

$$\begin{aligned} 110\% \text{ of } 80 &= \frac{110}{100} \times 80 \\ &= \frac{11}{10} \times 80 \\ &= 11 \times 8 \\ &= 88 \end{aligned}$$

Price reduction in a sale may be expressed as a **percentage decrease**.

You decrease an amount by taking away.



If an amount is **decreased**, the new amount is **less than 100%**.

Example 2: Decrease 80 by 25%.

First find 25% of 80: $\frac{1}{4} \text{ of } 80 = 20$

The question is about percentage decrease, so take away: $80 - 20$

Answer: 60

You can do the decrease in one calculation: $100\% - 25\% = 75\%$

$$\begin{aligned} 75\% \text{ of } 80 &= \frac{3}{4} \times 80 \\ &= \frac{3}{4} \times 80 \\ &= 3 \times 20 \\ &= 60 \end{aligned}$$

Try the skill

1. Increase 60 by 10%.

2. Decrease 40 by 10%.

3. Increase 84 by 20%.

4. Decrease 76 by 20%.

5. Ruth gets 60 marks in her maths test.

- a Rachel gets 5% more marks. How many marks did Rachel get?

- b Rafi q gets 5% less marks than Ruth. How many marks did Rafi q get?

6. Sajid earns £285 a week. This is due to increase by 10%. How much will his new wage be?

7. Kathy puts £2 000 into a savings account. The interest rate is 5% per annum. How much will she have in her account after one year, including the interest?

Tip

Ask yourself whether a question is asking for the new increased number, or just the increase.

Remember

'Per annum' means each year.

Remember what you have learned

First complete this ...

A percentage is a number out of _____.

$$\frac{50}{100} = \frac{1}{2}, \text{ so } \frac{1}{2} \times 100\% = 50\%.$$

$$\frac{25}{100} = \frac{1}{4}, \text{ so } \frac{1}{4} \times 100\% = 25\%.$$

$$\frac{10}{100} = \frac{1}{10}, \text{ so } \frac{1}{10} \times 100\% = 10\%.$$

50% is a half so, to find 50% of an amount, you _____ it or divide by _____.

▶ To find 10% of an amount you divide by _____.

▶ To find one quantity as a percentage of another:

▶ _____ the first quantity by the second: $\frac{\text{first}}{\text{second}}$

▶ then _____ the answer by 100%: $\frac{\text{first}}{\text{second}} \times 100\%$

▶ If an amount is increased, the new amount _____ is than 100%.

▶ If an amount is decreased, the new _____ amount is than 100%.

Tip

The three types of percentage question commonly asked are:

- find the percentage of a quantity
 - increase or decrease a number by a given percentage
 - express one quantity as a percentage of another.
- Learn how to do them all.

1. Of 900 people who went to a concert, 60% of them were female.

How many were female?

A ☐ 150

B ☐ 360

C ☐ 600

D ☐ 540

2. Of the members at a gym, two-fifths were sent by their doctors to lose weight.

What is two-fifths as a percentage?

A ☐ 12%

B ☐ 20%

C ☐ 25%

D ☐ 40%

3. Of the residents in a street, 75% subscribe to satellite TV.

What fraction of the residents subscribe to satellite TV?

A ☐ $\frac{3}{4}$

B ☐ $\frac{1}{4}$

C ☐ $\frac{1}{3}$

D ☐ $\frac{1}{2}$

4. The normal price for a mountain bike is £402. A shop is selling the bike in a sale at a 20% discount. How much is the discount?

A ☐ £8.04
B ☐ £20.10
C ☐ £40.20
D ☐ £80.40

5. What is one tenth as a percentage?

A ☐ 100%
B ☐ 10%
C ☐ 1%
D ☐ 0.1%

6. There are 80 guests at a wedding reception. 30% of them do not eat meat.

How many guests do not eat meat?

A ☐ 24
B ☐ 30
C ☐ 50
D ☐ 56

7. In an office, 75% of staff eat in the company's canteen.
What fraction does not eat in the canteen?

A ☐ $\frac{3}{4}$
B ☐ $\frac{1}{4}$
C ☐ $\frac{1}{3}$
D ☐ $\frac{1}{2}$

8. Out of 444 people working at a local factory, 111 joined the union.

What percentage of employees are in the union?

A ☐ 25%
B ☐ 4%
C ☐ 20%
D ☐ 44%

9. At a local cinema, 250 people attended the 8.30pm showing of a film. Of these people, 40% were senior citizens.

How many people attending this film were senior citizens?

A ☐ 40
B ☐ 80
C ☐ 100
D ☐ 120