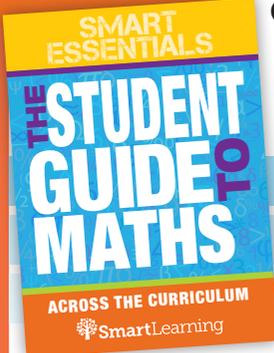


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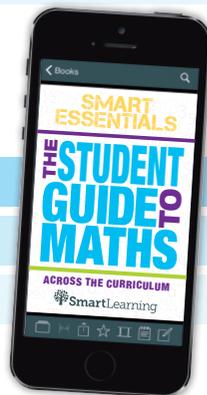
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3: PERCENTAGES

Percentages

WHAT IS IT?

Percentages are a way of using place value to compare between two or more scores or quantities.

WHAT'S THE MATHS?

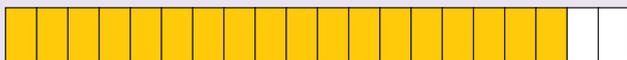
You will use percentages in many areas of life both in and out of school.

When baking bread the 'baker's percentage' allows a recipe to be adapted for the quantity of flour. The amount of water needed is 60% of the weight of the flour, the amount of yeast is 5% and the amount of salt is 10%.

In PE you might need to find 70% of your maximum heart rate in order to calculate when you are improving cardio fitness.

Even in Religious Studies you might need to use calculation! For example, if you study the pillars of Islam and need to work out zakat, the 2.5% of income expected of all Muslims as a charitable donation.

When a score is written as a percentage, it is converted to being 'out of 100'. This picture shows a score of 18 out of 20:



Converting it to a percentage can be thought of as turning it into a figure out of 100 like this:



90 of these 100 sections are shaded, we say that 90% is shaded.

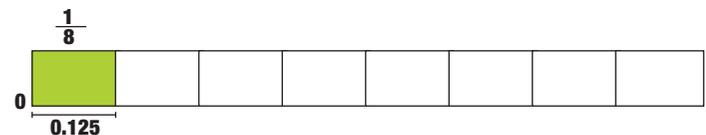
The symbol % is used to show that a quantity has been converted to a percentage, a number out of 100.

WHY DOES IT WORK?

This rod shows one out of the eight sections shaded. This means that the fraction $\frac{1}{8}$ is shaded.

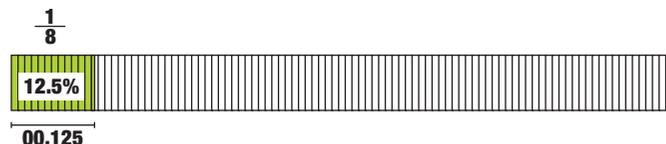


Taking the same rod, with the same proportion shaded and labelling the end as 1



dividing the 1 into 8 equal sections, $1 \div 8$ means that the length of each section is 0.125.

Still using the same rod, with the same section shaded, but this time scaling it up to be out of 100 means that the shaded area is also 100 times greater. Using place value we can calculate that 100 times greater than 0.125 is 12.5.



Here there are three different ways to describe the same image. We can say that $\frac{1}{8}$, 0.125 or 12.5% of the rod is shaded.

The fraction, decimal and percentage are just different ways to describe how much of the bar is shaded.



Writing a quantity as a fraction

HOW TO WORK IT OUT

The method to write a score as a percentage is often described something like this:

To change a score of 26 out of 40 to a percentage first calculate $26 \div 40$ which gives 0.65.

Now multiply 0.65 by 100 to make a percentage, giving 65%.
So 26 out of 40 is 65%.

A second example might be to change the fraction $1/8$ to a percentage
First calculate $1 \div 8$ which gives 0.125
Now multiply by 100 to give 12.5%
So $1/8$ can be written as 12.5%

WATCH OUT!

When moving from decimal to percentage, a calculator display can sometimes cause confusion. For example, the decimal 0.3 is 30% and the decimal 0.03 is 3%. A common mistake is to write a decimal 0.3 as 3% and it is important to think about place value (see chapter 2) to avoid making this error.

TRY IT OUT

Write these decimals as percentages:

0.3	0.335	0.08
0.03	0.95	0.80
0.035	0.59	

A percentage can be greater than 100. For example, the decimal 1.35 can be written as 135%.

Write these decimals as percentages:

1.3	1.335	1.08
1.03	1.95	1.80
1.035	1.59	

Write these scores as percentages:

15 out of 20	19 out of 20	1 out of 20
15 out of 40	19 out of 40	1 out of 40
15 out of 80	19 out of 80	1 out of 80
15 out of 100	19 out of 100	1 out of 100

In her science test Matilda scored 18 out of 20 marks and in her maths test she scored 22 out of 25 marks. In which test did Matilda do better?

HOW HARD CAN IT BE?

To make a percentages question difficult the total may be 'hidden'. For example if, in a class there are 17 girls and 15 boys, to calculate the percentage of the class that are boys you'll first need to find the total number of people. $17 + 15$ means that there are 32 children in the class and 15 of them are boys.

If you can follow the reasoning and work out an answer of around 47% then you can feel confident that you can change a fraction to a percentage.

Finding a percentage of an amount

HOW TO WORK IT OUT

Finding a percentage of an amount is the flip side of writing a score as a percentage.

For example, if there was a test and Sarah scores 65% of the 20 possible marks, how many marks did she score?

To solve this we need to find 65% of 20.

It's common to hear something like 'to find a percentage of an amount you need to multiply the amount by the percentage as a decimal'.

In this case that means writing 65% as the equivalent decimal, 0.65 and then multiplying this by 20:

$$0.65 \times 20 = 13$$

so 65% of 20 is 13.

WHY DOES IT WORK?

This picture shows a rod split into 100 sections. 65 of them are shaded so 65% of the bar is shaded.



The same percentage of this bar is shaded but this time the bar is 1 unit long. Using place value we know that 0.65 of the bar is shaded:



This rod is 20 times longer than the last one, but the shaded section is still the same percentage. This means that the shaded section must also be 20 times longer:

$$0.65 \times 20 = 13, \text{ so } 65\% \text{ of } 20 \text{ is } 13$$



The first step converts the percentage to a decimal and the second step scales that decimal so that it is out of the correct amount.

WATCH OUT!

As always when working with percentages it is important to take care when converting to decimals. Use what you know about place value to divide and multiply by 100 accurately.

TRY IT OUT

Find...

15% of 38	15% of 98	115% of 38
20% of 38	20% of 98	120% of 38
5% of 38	5% of 98	105% of 38
95% of 38	95% of 98	195% of 38
1% of 38	1% of 98	101% of 38

HOW HARD CAN IT BE?

Some percentages are more awkward to convert to decimals than others and it's worth making sure that you're completely confident with this.

If you can use a calculator to work out 10.35% of 32 using just one multiplication then you can be confident that you can find a percentage of an amount.

It's also worth remembering that, as in the above practice, percentages can be greater than 100 so sometimes finding a percentage can increase the value!

Increasing and decreasing by a percentage

HOW TO WORK IT OUT

When decreasing an amount by a percentage, for example, decreasing £70 by 15%, the method can be described as follows:

We know that 100% of the amount is £70

Decreasing 100% by 15% means that we need to find 85%

85% of £70 is found by calculating $0.85 \times 70 = 59.5$

So decreasing £70 by 15% gives £59.50.

When *increasing* an amount by a percentage, for example, increasing £70 by 15% the method can be described as follows:

We know that 100% of the amount is £70

Increasing 100% by 15% means that we need to find 115%

115% of £70 is found by calculating $1.15 \times 70 = \text{£}80.5$

So increasing £70 by 15% gives £80.50.

WHY DOES IT WORK?

It can be helpful to have a picture in your mind to help understand what's going on.

For example, when decreasing £70 by 15% you might imagine a rod, as in the earlier sections on percentage.

To reduce by 15% one strategy would be to find 15% and take it away, calculating what's left.



However, simplifying this down to one calculation allows for a more efficient and flexible approach.



WATCH OUT!

Adding and (particularly!) subtracting decimals can lead to mistakes if you're not paying full attention. When calculating the decimal to use for percentage decreases make sure that you're careful.

You might also occasionally find yourself working out 30% of an amount rather than reducing it by 30% so make sure that you read the question very carefully!

TRY IT OUT

Increase the following amounts by the given percentage

£60 by 15%	£65 by 15%	£165 by 15%
£60 by 25%	£65 by 25%	£165 by 25%
£60 by 35%	£65 by 35%	£165 by 35%
£60 by 5%	£65 by 5%	£165 by 5%
£60 by 95%	£65 by 95%	£165 by 95%
£60 by 0.5%	£65 by 0.5%	£165 by 0.5%

Decrease the following amounts by the given percentage

£60 by 15%	£65 by 15%	£165 by 15%
£60 by 25%	£65 by 25%	£165 by 25%
£60 by 35%	£65 by 35%	£165 by 35%
£60 by 5%	£65 by 5%	£165 by 5%
£60 by 95%	£65 by 95%	£165 by 95%
£60 by 0.5%	£65 by 0.5%	£165 by 0.5%

HOW HARD CAN IT BE?

As always with percentages, converting between decimals and percentages is key, and some values can seem more difficult to work with than others. If you can increase and decrease £314 by 3.05% and feel confident in your answers then you can be confident that you're able to calculate percentage changes.

Undoing a percentage increase or decrease

HOW TO WORK IT OUT

This type of question undoes as multiplication and so it is often stressed that reversing a percentage change means doing a division.

A typical question is something like this:

A shirt is reduced by 15% to £29.75. How much was the shirt originally?

And is explained like this:

A reduction of 15% means that 85% is left

85% is 0.85

$$29.75 \div 0.85 = 35$$

So the shirt originally cost £35.

And, in the same way, to calculate the original value after a percentage increase an example is:

If a TV costs £300 including 20% tax, how much would it cost before the tax is added on?

And is explained like this:

An additional 20% is written as 1.2 as a decimal.

This means that the original price has been multiplied by 1.2 so, to undo that

$$300 \div 1.2 = 250$$

So the TV originally cost £250.

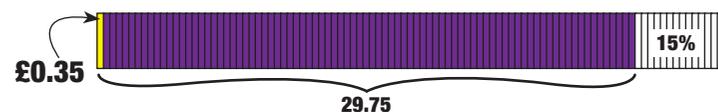
WHY DOES IT WORK?

Looking at the two examples and using a rod to represent what we know...

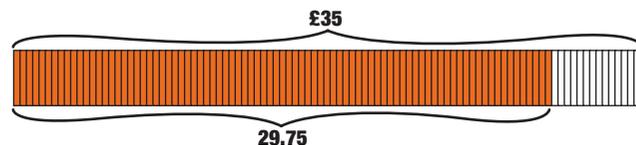
To work out the percentage reduction we know that 85% of the total rod is £29.75



dividing by 85 gives the value of 1%



then multiplying by 100 gives 100%, the original price.

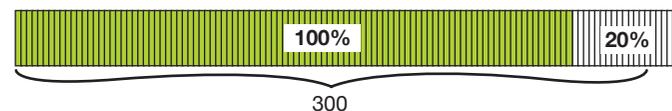


So the original price was £35.

The process of dividing by 85 and multiplying by 100 can be shortcut to divide by 0.85.

When undoing a percentage increase we can again use the rod to represent what is happening.

The additional 20% means that the rod is worth 120%



300