Learning Enhancement Team

Steps into Numeracy

Using Percentages

This study guide is designed to help you understand how to calculate and use percentages in both daily life and your studies.

Introduction: What is a percentage?

The term **percentage** is frequently used in everyday and academic language and is given the symbol %. A clue to the meaning of a percentage lies in the word itself:

> *per* meaning 'divide by'
>
> *cent* meaning '100'

In other words the symbol % represents the mathematical operation of **dividing by 100**. Importantly **a percentage only has a meaning when applied to a given quantity**. For example it is common to see retail sales expressed as *20% off* [a given price] or restaurant bills with a 10% service charge [of the total bill]. Many newspaper reports discussing taxes, unemployment figures and the economy use percentage as a simplified means of conveying size, scale or value *with respect to a given figure*. Percentages are useful for representing increases and decreases in a given figure or quantity.

There are some specific percentages which have a special meaning: 100% represents the whole of something and 0% represents none of it. When statements which include percentages are used in complicated contexts your intuition may not be reliable and you should take care when drawing conclusions from such statements. For example when percentages are discussed you may hear figures which are over 100%: whether this is appropriate or not depends on the context. For example it is perfectly acceptable for a business person to state that profits have increased by 110%, however people who talk of giving 110% effort are showing a fundamental misunderstanding of percentages.

It is also worth remembering that, large percentages of very small numbers are still very small numbers and small percentages of very large numbers can still be large numbers.

Using percentages in calculations

A percentage can be thought of as so many parts out of 100 individual parts. You can think of taking a whole and dividing it into 100 equally sized pieces - each piece representing one percent of that whole. Recognising that the symbol % represents a short-hand for the mathematics "$\div 100$", allows you to express a percentage in different ways, either as a fraction or as a decimal number. It is useful if you are comfortable converting between the three representations: percentage, decimal and fraction. Practising these conversions will make working and calculating with percentages easier and more natural (see study guide: *Percentages*).

There are many instances in which you may have to perform a calculation using a percentage. You can use a simple translation technique to convert some questions involving percentages into mathematics, as you shall see below. This method involves replacing the % symbol with $\div 100$ and also the word 'of' with 'multiply'. In short:

%	changes to	$\div 100$
of	changes to	multiply, $\times$

Strategies for performing the resulting multiplication can be found in the study guides: *Multiplying Small Numbers* and *Multiplying Numbers*.

Finding a percentage of a given value or amount

Finding a proportion of a given value or amount is a very common use for percentages.

Example: What is 60% of £360?

To find the answer you should translate the question into mathematics by replacing the '%' symbol with '$\div 100$' and the word 'of' with the multiplication symbol '$\times$'. You may also find it useful to introduce brackets to help you see that the % *belongs* to the 60. Doing this means that the question '60% of £360' translates to the mathematics:

$$(60 \div 100) \times £360$$

which can then be performed as follows:

$$(60 \div 100) \times £360 = 0.6 \times £360 = £216$$

This tells you that £216 is 60% of £360. Notice that the decimal form of the percentage is used in the calculation and the answer is in pounds.

Finding a percentage decrease (so-many percent off)

When shops have sales they usually take so-many percent from the price of goods. Being able to calculate how much to pay in these circumstances is very useful.

Example: A retail store is offering all goods at 75% off the original price. If a pair of shoes is originally priced at £65 what is the sale price?

These types of problems use the fact that 100% represents the whole of something. Here 100% is £65, if you reduce this by 75% you have 25% remaining as:

$$100\% - 75\% = 25\%.$$

So the question is really asking 'what is 25% of £65?' which is a problem similar to that in the previous section. After translation into mathematics 25% of £65 becomes $(25 \div 100) \times £65$ which can be calculated as follows:

$$(25 \div 100) \times £65 = 0.25 \times £65 = £16.25$$

So if you reduce the price of a £65 pair of shoes by 75% you will pay £16.25.

Example: Unemployment has decreased by 0.1% from 2.3 million.

This example is a statement and does not contain a calculation as such. However you can work out how many people the 0.1% fall in unemployment represents. The 2.3 million unemployed people is set as 100% as this is the figure on which the reduction of 0.1% is based (this is often called the **benchmark figure**). A decrease of 0.1% from 100% gives 99.9% and the calculation 99.9% of 2.3 million will give the new level of unemployment after the 0.1% drop. After translating this into mathematics the calculation is:

$$(99.9 \div 100) \times 2300000 = 0.999 \times 2300000 = 2297700$$

You can also calculate how many people this drop in unemployment represents. This can be achieved in one of two ways. Firstly you can subtract 2297700 from 2.3 million or calculate 0.1% of 2.3 million. Either way the result is that unemployment has dropped by 2300 people.

Finding a percentage increase

Many situations require finding percentage increases, for example the addition of a tax (such as VAT) onto costs. Being able to do these types of calculations are beneficial when considering the final costs of goods and services.

Example: The cost of building an extension to a house is estimated to be £38000 before the addition of 20% VAT. How much is the total cost?

As in the previous examples concerning percentage decrease, the method of answering these types of questions is that the whole of something is 100%. Here the £38000 is 100%, with an additional 20% the cost of the project will be 120% of £38000. After translating this into mathematics you should find that:

$$(120 \div 100) \times £38000 = 1.2 \times £38000 = £45600$$

Which tells you the total cost, after the addition of tax is £45600.

Finding an original value after a percentage increase or decrease

You may see charges or prices in shops expressed as "...after 5% sales tax" or "...after 10% surcharge added" and you may want to calculate the original cost. Finding the original cost involves a small piece of algebra which leads to a useful method which is best illustrated by an example.

Example: The original cost of a service has been increased by 10% to £66, what is the original cost of the service before the increase?

The original cost has been increased by 10% to £66, in other words £66 is 110% of the original cost. In algebra unknown quantities are conventionally represented by the letter *x* so you can write that:

110% of *x* is £66

Or mathematically, using $110\% = 110 \div 100 = 1.1$:

$$x \times 1.1 = £66$$

To find *x* you need to account for the multiplication by 1.1. As division undoes multiplication the value of *x* is calculated by 66 divided by 1.1. So:

$$x = \frac{£66}{1.1} = £60$$

which tells you that the original cost of the service was £60.

You can write general methods to perform calculations of this type which are given in the box on the following page.

1.	If you are dealing with a **percentage increase**, add the increase to 100% and convert this percentage to a decimal. Divide the value **after the increase** by this decimal number to give the original value.

2.	If you are dealing with a **percentage decrease**, subtract the decrease from 100% and convert the resulting percentage to a decimal. Divide the value **after the decrease** by this decimal number to give the original value.

Example:	The amount of fat in a food product has been reduced by 15% to 17g. What was the original amount of fat?

The decrease is 15%. If you subtract this from 100% you get 85%.

Expressed as a decimal, $85\% = 85 \div 100 = 0.85$.

So to find the original amount of fat you divide 17g by 0.85 so;

$$\frac{17}{0.85} = 20$$

which tells you that there was 20g of fat in the food product before the reduction.

Finding a percentage difference (percentage change)

Another common use of percentages is to be asked to express the difference between two numbers or quantities as a percentage change: "an increase of...%" or "a decrease of...%". You will always have a figure/quantity to compare to a benchmark and it is important to be sure which is figure is the benchmark and which is the figure you are comparing with. Usually these calculations do not result in neat, whole number solutions and so you should round your answers to a suitable number of significant figures or decimal places.

Example:	Average attendance in class has decreased from 65 in semester A to 50 in semester B, what is this decrease expressed as a percentage?

To start this calculation you need to work out what percentage of 65 is represented by 50. To do this you must divide 50 by 65 (to give a fraction) and multiply the result by 100 (to change the fraction into a percentage). So (to 3 significant figures):

$$(50 \div 65) \times 100 = 76.9\%$$

This result is saying that 50 is 76.9% of 65. As 65, your benchmark, is equivalent to 100%, the percentage **difference** from 100% to 76.9% is 23.1%. Alternatively you could say that the percentage **decrease** from semester A to semester B is 23.1%.

Example: Average scores in a module test have increased from 40 to 52 year-on-year. What is this increase expressed as a percentage?

Again here you must calculate what percentage of 40 (the benchmark) is represented by 52 by dividing 52 by 40 and then multiplying the result by 100:

$$(52 \div 40) \times 100 = 130\%$$

So 52 is 130% of 40. As 40 represents 100% you have seen a 30% increase year-on-year.

Want to know more?

If you have any further questions about this topic you can make an appointment to see a **Learning Enhancement Tutor** in the **Student Support Service**, as well as speaking to your lecturer or adviser.

	Call:	01603 592761
	Ask:	ask.let@uea.ac.uk
	Click:	https://portal.uea.ac.uk/student-support-service/learning-enhancement

There are many other resources to help you with your studies on our website.
For this topic, these include questions to practise, model solutions and a webcast.

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