

**MU120\_4M3   Open mathematics**

**Ratio, proportion and percentages**

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## Introduction

The topics in this free course, Ratio, proportion and percentages, are concerned with dividing something into parts. For example, if there are 200 people living in a small village, and 50 of these are children, this could be expressed as a percentage:

 25% of the village population are children;

or as a ratio:

  one in every four people is a child or there is 1 child for every three adults;

or a proportion:

  the proportion of children in the village population is a quarter.

This OpenLearn course provides a sample of level 1 study in [Mathematics](http://www.open.ac.uk/courses/find/mathematics?utm_source=openlearn&utm_campaign=ol&utm_medium=ebook).

## Learning outcomes

After studying this course, you should be able to:

* work with simple ratios
* convert between fractions, decimals and percentages
* explain the meaning of ratio, proportion and percentage
* find percentages of different quantities
* calculate percentage increases and decreases.

## 1 Ratio

## 1.1 Introduction

Ratios crop up often in official statistics. The government wants the teacher–pupil ratio in schools to be increased to one teacher to thirty pupils or less. The birth rate has fallen: the ratio of children to women of child bearing age has gone down. It used to be 2.4 to 1, and now it is 1.9 to 1. Predictions for the ratio of working adults to retired adults is disturbing. Predictions are, that by 2030 the ratio will be two working adults to every retired person, instead of three to one now, and four to one ten years ago.

Often ratios are implicit in the language rather than explicitly referred to: one teacher for 30 pupils; 2.4 children per woman of child bearing age; one retired person per two working adults. The word ‘per’ often indicates that the concept of ratio is being used.

## 1.2 Expressing ratios

To make short crust pastry, one recipe book says ‘use one part of fat to two parts of flour’; another recipe says ‘use fat and flour in the ratio of one to two’; and yet another says ‘use half as much fat as flour’. These are different ways of expressing the same ratio. Ratios are often expressed as fractions. So in this case:

Start of $1



End of $1

Since you can multiply top and bottom of a fraction by the same number and get an equivalent fraction, you can use the ratio in a number of ways. If you have 100 grams of fat then

Start of $1



End of $1

So you need 200 grams of flour to 100 grams of fat. There are many ways to arrive at this answer. The important point is that a ratio of 100 to 200 is equivalent to 1 to 2.

To make concrete, the instructions are ‘use sand and cement in the ratio three to one’. This means

Start of $1



End of $1

If you have 30 kg of cement, then you need 90 kg of sand.

The conversion rates between currencies or different units are often easier to remember as ratios. Many people remember that the ratio of distance in miles to the same distance in kilometres is five to eight.

Start of Example

**Example 1**

At the time of writing the ratio of prices in pounds sterling to prices in euros is two to three (2 : 3). What is the equivalent price in pounds for a coat costing 150 euros?

[View answer - Example 1](%22%20%5Cl%20%22Session1_Answer1)

End of Example

### 1.2.1 Try some yourself

Start of Activity

**Activity 1**

Start of Question

A friend is painting the inside walls of a garage. So far she has used a 2 litre tin of emulsion paint and covered an area of 9 m2. She needs some more paint. How much more would you advise her to purchase if she intends to paint all the walls and ceiling, which is a total area of 75 m2.

End of Question

[View answer - Activity 1](%22%20%5Cl%20%22Session1_Answer2)

End of Activity

Start of Activity

**Activity 2**

Start of Question

If the ratio of distance measured in miles to the same distance measured in kilometres is five to eight, which is the higher speed limit, 70 miles per hour or 110 kilometres per hour?

End of Question

[View answer - Activity 2](%22%20%5Cl%20%22Session1_Answer3)

End of Activity

## 1.3 Using ratios

Time conversions are also ratios. The ratio of time measured in minutes to time measured in seconds is one to sixty (1:60), as there are sixty seconds in a minute.

Start of Example

**Example 2**

Adam's grandfather ran a mile in  minutes. Adam took 260 seconds. Which is greater, 260 seconds or  minutes? Did Adam run faster than his grandfather?

[View answer - Example 2](%22%20%5Cl%20%22Session1_Answer4)

End of Example

When shopping for a bargain, the ratio of price to quantity is often a useful way of comparing prices of different sized packets.

Start of Example

**Example 3**

A local shop sells ready-made custard at £1.45 for a special offer pack of three 425 g tins. It also sells the same brand of custard in 1 kg cartons costing £1.29 each. Which is the better bargain?

[View answer - Example 3](%22%20%5Cl%20%22Session1_Answer5)

End of Example

### 1.3.1 Try some yourself

Start of Activity

**Activity 3**

Start of Question

A local supermarket sells a popular breakfast cereal in a ‘Large Pack’ and ‘New Extra Large Pack’. They are both being sold at ‘knock down’ prices. The large pack contains 450 g of cereal priced at £1.85. The new extra large pack contains 625 g and is priced at £2.35. Which is the better bargain?

End of Question

[View answer - Activity 3](%22%20%5Cl%20%22Session1_Answer6)

End of Activity

Start of Activity

**Activity 4**

Start of Question

Baking potatoes are priced at 75 p for a pack of three (very similar) potatoes or at £2.70 for a 5 kg bag. How heavy does each of the three potatoes in the pack have to be in order for the pack to be a better bargain than the 5 kg bag? Does your answer seem reasonable? (Try to imagine a potato of this size.)

End of Question

[View answer - Activity 4](%22%20%5Cl%20%22Session1_Answer7)

End of Activity

## 1.4 Converting ratios from fractions to decimals

Although ratios are often given as fractions, they can also be expressed as decimals. You need to deal with a mixture of fractions and decimals, and to compare ratios given in either form, so you need to be able to convert between the two forms.

Start of Example

**Example 4**

The ratio of the circumference of a circle to its diameter is a constant denoted by  (the Greek letter p) pronounced pi, it has been approximated by a number of different fractions. One such fraction is , another is 355/113. How do these compare with the decimal value from a calculator of 3.141592 654?

[View answer - Example 4](%22%20%5Cl%20%22Session1_Answer8)

End of Example

Start of Example

**Example 5**

Suppose you had been told that the ratio between a distance measured in miles and the same distance measured in kilometres is about 0.625. Convert this to a fraction.

[View answer - Example 5](%22%20%5Cl%20%22Session1_Answer9)

End of Example

### 1.4.1 Try some yourself

Start of Activity

**Activity 5**

Start of Question

Convert each of the following fraction ratios to decimal ratios.

* (a) 
* (b) 
* (c) 
* (d) 

End of Question

[View answer - Activity 5](%22%20%5Cl%20%22Session1_Answer10)

End of Activity

Start of Activity

**Activity 6**

Start of Question

Convert each of the following decimal ratios to fraction ratios.

* (a) 0.25
* (b) 1.135
* (c) 0.064

End of Question

[View answer - Activity 6](%22%20%5Cl%20%22Session1_Answer11)

End of Activity

Start of Activity

**Activity 7**

Start of Question

A recipe for a casserole involves soaking dried beans. The beans require  litres of water per kilogram of beans. If you have  kilograms of beans, how much water is required?

End of Question

[View answer - Activity 7](%22%20%5Cl%20%22Session1_Answer12)

End of Activity

## 1.5 Speeds

Speed is the ratio of distance travelled to time taken. A runner's speed may be quoted in metres per second, miles per hour or kilometres per hour. The units are given as:

   unit of distance per unit of time.

When you have a distance covered (such as a mile) and a time taken (such as four minutes) the average speed is defined as

* Start of $1



End of $1

The formula for average speed applies even over a journey made up of several stages.

Start of Example

**Example 6**

In 1999, Hicham El Guerrouj held the record for running a mile. He covered the distance in just over 3 minutes 43 seconds. In the same year he also held the world record for the 1500 m race. He completed this distance in 3 minutes 26 seconds.

Work out:

* (a) his (average) speed in miles per hour for the 1 mile race;
* (b) his (average) speed in kilometres per hour for the 1500 metre race;
* (c) compare (a) and (b). In which race was his (average) speed faster assuming that 1.61 km = 1 mile?

[View answer - Example 6](%22%20%5Cl%20%22Session1_Answer13)

End of Example

### 1.5.1 Try some yourself

Start of Activity

**Activity 8**

Start of Question

Which is greater, 1.2 minutes or 70 seconds?

End of Question

[View answer - Activity 8](%22%20%5Cl%20%22Session1_Answer14)

End of Activity

Start of Activity

**Activity 9**

Start of Question

Answer the following questions:

* (a) A cheetah is the fastest land animal over short distances. It can run 400 metres in 15 seconds. What would be its speed in metres per second and kilometres per hour?
* (b) The slowest moving land animal is the three-toed sloth from tropical America. It takes 16 hours to travel a mile. What is this speed in kilometres per hour and in metres per second? (5 miles is approximately 8 km.)

End of Question

[View answer - Activity 9](%22%20%5Cl%20%22Session1_Answer15)

End of Activity

Start of Activity

**Activity 10**

Start of Question

Which is longer, 11 minutes or 0.17 hours?

End of Question

[View answer - Activity 10](%22%20%5Cl%20%22Session1_Answer16)

End of Activity

Start of Activity

**Activity 11**

Start of Question

A van driver averages 50 km per hour travelling on ordinary roads and 70 km per hour on motorways. Estimate:

* (i) how far the van will travel in  hours;
* (ii) how long it will take to travel 160 km;

when travelling on (a) ordinary roads and (b) motorways.

End of Question

[View answer - Activity 11](%22%20%5Cl%20%22Session1_Answer17)

End of Activity

## 2 Proportion

## 2.1 Introduction

Proportion is another way of expressing notions of part and whole. You might say that the proportion of village inhabitants who are children is a quarter, or that the proportion of fruit juice in the punch is two thirds, or that the proportion of sand in the concrete is three quarters.

All these examples involve the fractions , , . Problems involving proportions are best handled by manipulating fractions, generally, by division or multiplication. The task is to decide which fraction to manipulate, in what way, and at what stage!

## 2.2 Direct proportion

In a recipe the quantity of each ingredient needed depends upon the number of portions. As the number of portions increases, the quantity required increases. The quantity per portion is the same. This is called direct proportion. The quantity is said to be **directly proportional** to the number of portions. If 2 potatoes are required for one portion, 4 will be required for two portions etc. A useful method for direct proportion problems is to find the quantity for one and multiply by the number you want.

Start of Example

**Example 7**

John lives with three cats. His daughter asks him to look after her cat for a week while she goes away. John normally buys two tins of cat food a day for the three cats. How many tins should he buy for the four cats for a week?

[View answer - Example 7](%22%20%5Cl%20%22Session2_Answer1)

End of Example

Start of Example

**Example 8**

Debbie is checking her phone bill. Her mobile phone calls have all been charged at the same rate, 30 pence per minute. (Call charges are rounded to the nearest penny and charged to the nearest second.)

* (a) She wants to check the cost of a call to her friend. The call lasted 7 minutes and 34 seconds. How much should she have been charged?
* (b) How long, at this rate, can she speak to her friend if the call charge is to cost no more than £2.50?

[View answer - Example 8](%22%20%5Cl%20%22Session2_Answer2)

End of Example

### 2.2.1 Try some yourself

Start of Activity

**Activity 12**

Start of Question

A recipe for four people calls for  teaspoon of mustard powder. How much should you use for ten people?

End of Question

[View answer - Activity 12](%22%20%5Cl%20%22Session2_Answer3)

End of Activity

Start of Activity

**Activity 13**

Start of Question

The length of time it takes to cook a Christmas pudding in a pressure cooker depends on the weight of the pudding. Kim has forgotten the time per pound but remembers that her  kg pudding takes 5 hours.

How long will it take to cook a 2 kg pudding?

End of Question

[View answer - Activity 13](%22%20%5Cl%20%22Session2_Answer4)

End of Activity

## 2.3 Inverse proportion

In [Section 2.2](#sec002_002) you saw that direct proportion described relationships between two quantities, where as one increased, so did the other. Sometimes as one quantity increases the other decreases instead of increasing. This is called indirect proportion. Team tasks are often an example of this. The time taken to do a job is indirectly proportional to the number of people in the team.

A difficulty with the real-life context of such problems is that, in many cases, it is hard to believe that people working in a team will work at the same rate regardless of the size of the team, unless the team work independently, i.e. ‘in parallel’. The main idea behind this type of problem is that increasing the number of people working decreases the time taken to complete the task. (An obvious exception to this is decision-making in a committee: if two people can reach a decision in an hour, four people are liable to take twice as long!)

Such problems can be compared with certain problems involving speed: doubling the number of people working is the same as doubling the speed at which the team work. In either case the time is halved. It is useful to find out how long it would take one person to do the whole job, then divide by the number of people sharing the work. This is a good approach to most indirect proportion problems.

Start of Example

**Example 9**

A team of five people can deliver leaflets to every house on a housing estate in three hours. How long will it take a team of just two people?

[View answer - Example 9](%22%20%5Cl%20%22Session2_Answer5)

End of Example

### 2.3.1 Try some yourself

Start of Activity

**Activity 14**

Start of Question

A piece of computer software is to be developed by a team of programmers. It is estimated that a team of four people would take a year. Which of the following times is the length of time taken by three programmers?

  **A** 1 year 3 months  **B** 9 months  **C** 1 year 4 months

End of Question

[View answer - Activity 14](%22%20%5Cl%20%22Session2_Answer6)

End of Activity

Start of Activity

**Activity 15**

Start of Question

A 10 kg bag of potatoes lasts for a week when used in catering for 7 people.

* (a) How long will it last for 2 people, assuming everybody eats the same amount?
* (b) If, instead of buying a 10 kg bag (which might not keep well), you want to buy fresh potatoes every week, how much per week should you buy for 2 people?

End of Question

[View answer - Activity 15](%22%20%5Cl%20%22Session2_Answer7)

End of Activity

Start of Activity

**Activity 16**

Start of Question

Two workers in the Open University warehouse take 20 minutes to stick labels on 500 packages for an MU120 mailing. There are still 4000 more packages. How many workers are required, if the job is to be done in about a further hour?

End of Question

[View answer - Activity 16](%22%20%5Cl%20%22Session2_Answer8)

End of Activity

## 3 Percentages

## 3.1 What are percentages?

Percentages are used, particularly in newspaper articles, to indicate fractions (as in ‘64% of the population voted’) or to indicate changes (as in ‘an increase of 4%’).

Percentages often indicate proportions. For example, labels in clothes indicate the various proportions of different yarns in the fabric. ‘Per cent’ means ‘per hundred’ and is denoted by the symbol %. 100% is the same as the whole, or one hundred per hundred.

Start of Figure



[View description - Uncaptioned Figure](%22%20%5Cl%20%22Session3_Alternative1)

End of Figure

   100% cotton indicates that the fabric is made entirely from cotton. (100 parts out of 100 parts).

   60% cotton means that   (or 0.6) of the fabric is cotton.

   40% polyester means that   (or 0.4) is polyester.

The percentages on the label should total 100%, just as the corresponding fractions add up to 1, because the total (100%) refers to the whole garment. 60% + 40% = 100%, 0.6 + 0.4 = 1.

Percentages can also be manipulated as either fractions or decimals.

Start of Example

**Example 10**

A building society offers 90% mortgages to first-time buyers. How much would the Smiths get on a house valued at £150 000?

[View answer - Example 10](%22%20%5Cl%20%22Session3_Answer1)

End of Example

### 3.1.1 Try some yourself

Start of Activity

**Activity 17**

Start of Question

Express each of the following percentages as fractions:

* (a) 40%
* (b) 8%
* (c) 70%
* (d) 

End of Question

[View answer - Activity 17](%22%20%5Cl%20%22Session3_Answer2)

End of Activity

Start of Activity

**Activity 18**

Start of Question

Express each of the following percentages as decimals:

* (a) 50%
* (b) 85%
* (c) 7%
* (d) 

End of Question

[View answer - Activity 18](%22%20%5Cl%20%22Session3_Answer3)

End of Activity

Start of Activity

**Activity 19**

Start of Question

A survey was carried out on 840 couples to investigate family income. 75% of the women were in paid work; 90% of the men were in paid work; 18% of the couples had a joint income of less than £160 per week.

* (a) How many women were in paid work?
* (b) How many men were in paid work?
* (c) How many couples had a joint income of less than £160 per week?

End of Question

[View answer - Activity 19](%22%20%5Cl%20%22Session3_Answer4)

End of Activity

## 3.2 Converting to a percentage

Fractions and decimals can also be converted to percentages, by multiplying by 100%.

So, for example, 0.17, 0.3 and  can be expressed as percentages as follows:

  0.17 × 100% = 17%;

  0.3 × 100% = 30%;

  

Decimals or fractions bigger than 1 correspond to percentages greater than 100%. For example,

   = 1.75, which as a percentage is 1.75 × 100% = 175%.

Care needs to be taken when talking in percentages. A percentage is a percentage of a given quantity: 50% of the voters, 25% of the budget, 10% of the population. In newspapers, it is not always clear what quoted percentages are percentages of. Politicians too can give misleading statements. ‘We are giving an increase in funding of 10% and 5% of this has no strings attached’. In this statement it is not clear whether the 5% is 5% of the original funding or 5% of the 10% increase in funding (which would be  × 10% = 0.5% of the original funding).

To avoid this confusion some people use the term percentage points, when they are comparing the percentages of different quantities. In elections the percentage of the vote at one election for a given party is often compared with the percentage of the vote at the previous election. The difference is referred to as the ‘swing’ and expressed in percentage points.

Start of Example

**Example 11**

In a local election 2540 votes are cast for the Purple party out of a total of 5000 votes. At the previous election 42.1% of votes had been for the Purple party. What is the swing to the Purple party in percentage points?

[View answer - Example 11](%22%20%5Cl%20%22Session3_Answer5)

End of Example

### 3.2.1 Try some yourself

Start of Activity

**Activity 20**

Start of Question

Convert each of the following to percentages. Round off the percentages to whole numbers.

* (a)
	+ (i) 0.8
	+ (ii) 0.21
	+ (iii) 0.70
	+ (iv) 2.4
* (b)
	+ (i)  
	+ (ii)  
	+ (iii)  
	+ (iv)  

End of Question

[View answer - Activity 20](%22%20%5Cl%20%22Session3_Answer6)

End of Activity

Start of Activity

**Activity 21**

Start of Question

In the election in [Example 11](#exa011) the Average party gets 2100 votes. In the previous election they had 10%. Find the swing.

End of Question

[View answer - Activity 21](%22%20%5Cl%20%22Session3_Answer7)

End of Activity

## 3.3 Percentage increase and decrease

### 3.3.1 Increasing by a percentage

Our everyday experience of percentages includes percentage increases (like VAT at %, or a service charge of 15%) and percentage decreases (such as a discount of 15%).

For example, £8 plus % VAT means you actually have to pay

£8 + (% of £8).

% of 8 is  × 8 =   = 1.4

so the VAT is £1.40, and the sum you pay is £8 + £1.40 = £9.40.

There is another way of doing this calculation:

  100% of £8 plus % of £8 = (100% + %) of £8,

that is 117.5% of £8.

  117.5% of £8 = £(1.175 × 8)

   = £9.40 (as before).

Start of Example

**Example 12**

A restaurant bill comes to £76 before VAT and the service charge are added. VAT is added at  and the restaurant also adds a service charge of 15%. Does it make any difference to what you have to pay if the VAT is added first then the service charge or vice versa? Does it make a difference to the amount of VAT paid?

[View answer - Example 12](%22%20%5Cl%20%22Session3_Answer8)

End of Example

### 3.3.2 Try some yourself

Start of Activity

**Activity 22**

Start of Question

Answer the following questions

* (a) How much will this tennis racquet cost if VAT at  has to be added?

Start of Figure



[View description - Uncaptioned Figure](%22%20%5Cl%20%22Session3_Alternative2)

End of Figure

* (b) The racquet is put in the sale at 10% discount. What is its sale price, not including VAT?
* (c) If customers pay VAT and get the discount, how much do they pay? Does it make any difference to the customer whether the VAT is added first then the discount subtracted, or vice versa? Give a reason for your answer.

End of Question

[View answer - Activity 22](%22%20%5Cl%20%22Session3_Answer9)

End of Activity

Start of Activity

**Activity 23**

Start of Question

A commuter pays £1260 for a season ticket. The train company announces an increase of 7.4% on all its fares. How much will the season ticket cost after the increase?

End of Question

[View answer - Activity 23](%22%20%5Cl%20%22Session3_Answer10)

End of Activity

## 3.4 Decreasing by a percentage

Discount can be calculated in the same way as an increase by a percentage. For example, £8 with 15% discount means you actually pay

  £8 less (15% of £8)

  15% of 8 = × 8 =  = 1.2. So the discount is £1.20

  £8 − £1.20 = £6.80

Alternatively the actual amount can be calculated in another way, as follows:

  (100% − 15%) of £8 is 85% of £8.

  85% of £8 = £(0.85 × 8)

      = £6.80 (as before).

Start of Example

**Example 13**

* (a) A carpet store is offering 20% off all its oriental rugs. What would the sale price be for a Chinese rug originally priced at £245?
* (b) The business fails to do well and decides to close down. It makes a further reduction on all its stock of 12%. What would the same Chinese rug be sold for now?

[View answer - Example 13](%22%20%5Cl%20%22Session3_Answer11)

End of Example

### 3.4.1 Try some yourself

Start of Activity

**Activity 24**

Start of Question

A new train operator boasts ‘Train times reduced by 12%’. Decrease 90 minutes by 12%. Give your answer as minutes and seconds.

End of Question

[View answer - Activity 24](%22%20%5Cl%20%22Session3_Answer12)

End of Activity

Start of Activity

**Activity 25**

Start of Question

The population of a small town is 4650. It is predicted that the population will decrease by approximately 4% each year. What is the population likely to be after (a) one year, (b) two years?

End of Question

[View answer - Activity 25](%22%20%5Cl%20%22Session3_Answer13)

End of Activity

## 3.5 More examples of percentages

In lots of everyday situations percentages are used to make predictions and comparisons.

Start of Example

**Example 14**

The number of casualties handled by the outpatients department of a hospital increases by approximately 8% per year. The number of casualties this year was 1920. Make a prediction for the number of casualties handled (a) next year, (b) in two years' time.

[View answer - Example 14](%22%20%5Cl%20%22Session3_Answer14)

End of Example

### 3.5.1 Try some yourself

Start of Activity

**Activity 26**

Start of Question

Answer the following questions

* (a) What is 40% as a fraction?
* (b) What is   as a percentage?
* (c) What is 1.26 as a percentage?

End of Question

[View answer - Activity 26](%22%20%5Cl%20%22Session3_Answer15)

End of Activity

Start of Activity

**Activity 27**

Start of Question

In an election 1248 votes out of 3000 are cast for the Gold party. What is this as a percentage? If in the previous election 35.1% voted Gold, what is the swing to Gold in percentage points?

End of Question

[View answer - Activity 27](%22%20%5Cl%20%22Session3_Answer16)

End of Activity

Start of Activity

**Activity 28**

Start of Question

A quote from a builder for some home improvements is £2200 plus VAT.

* (a) If VAT is %, what is the amount including VAT?
* (b) If the builder gives 10% reductions for prompt payment, what would the amount be then (including VAT)?

End of Question

[View answer - Activity 28](%22%20%5Cl%20%22Session3_Answer17)

End of Activity

Start of Activity

**Activity 29**

Start of Question

An airline decides to increase its fares from London to Europe by 17% and its fares to North America by 15%. Before the increase a special offer European fare from London to Geneva was £165 and the North American fare from London to New York was £376. What would the new fares be for these trips after the increases?

End of Question

[View answer - Activity 29](%22%20%5Cl%20%22Session3_Answer18)

End of Activity

## 4 OpenMark quiz

Now try the [quiz](https://students.open.ac.uk/openmark/mu120-08.module3/), and see if there are any areas you need to work on.

## Conclusion

This free course provided an introduction to studying Mathematics. It took you through a series of exercises designed to develop your approach to study and learning at a distance and helped to improve your confidence as an independent learner.

## Keep on learning

Start of Figure



End of Figure

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## Solutions

## Example 1

#### Answer

3 euros are equivalent to 2 pounds. This means that

Start of $1



End of $1

So price in pounds = 2/3 × price in euros = 2/3 × 150 = 100

The equivalent price of the coat is £100.

[Back to - Example 1](%22%20%5Cl%20%22Session1_Example1)

## Activity 1

#### Answer

An area of 9 m2 requires 2 litres of paint. The ratio of paint to area is 2 to 9 or . So an area of 1 m2 would require  of a litre of paint. She needs to paint an area of (75 − 9) m2 or 66 m2. This will require   litres of paint (i.e. 14.666 67) litres or approximately 15 litres to the nearest  litres. So she needs 15 more litres of paint (rounded up).

[Back to - Activity 1](%22%20%5Cl%20%22Session1_Activity1)

## Activity 2

#### Answer

70 is 5 × 14, so

Start of $1



End of $1

70 miles is about the same as 112 kilometres.

Alternatively 1km =  miles. So 110 km = 110 ×  miles = 68.75 miles.

So the two speed limits are very close but with 70 miles per hour being the higher.

[Back to - Activity 2](%22%20%5Cl%20%22Session1_Activity2)

## Example 2

#### Answer

minutes is equivalent to  × 60 seconds.

is equivalent to . So this is  × 60 = 270 seconds.

So  minutes is just a bit longer than 260 seconds. Therefore Adam has run faster than his grandfather.

[Back to - Example 2](%22%20%5Cl%20%22Session1_Example2)

## Example 3

#### Answer

To compare the prices it would be best to compare the ratio of prices to amounts (measuring amounts in the same units) i.e. prices per kg.

Three 425 g tins will contain 3 × 425 g = 1275 g or 1.275 kg.

£1.45 for 1.275 kg is

  ≈  £1.14 per kg.

The 1 kg carton costs £1.29 per kg.

The three tins are 15 p cheaper per kg. So the three-tin pack is the better bargain.

[Back to - Example 3](%22%20%5Cl%20%22Session1_Example3)

## Activity 3

#### Answer

In order to compare the prices of the two cereal packs it is best to work out the price per gram for each.

The large packet will cost £1.85 for 450 g. This is  or 0.411 p per gram.

The New extra large packet will cost £2.35 for 625 g. This is  or 0.376 p per gram. Obviously the new extra large pack is the better bargain.

(But the extra large package is 37 cm tall (about 13˝). Unluckily it might not fit in the kitchen cupboard.)

[Back to - Activity 3](%22%20%5Cl%20%22Session1_Activity3)

## Activity 4

#### Answer

5 kg costs £2.70. You want to know, at this rate, how much you get for 75 p. First work out how much you get for £1:

   if £2.70 buys 5 kg then £1 buys   kg.

So 75 p should buy 0.75 ×    1.39 kg.

If three potatoes weigh 1.39 kg each, one weighs about 0.46 kg. So each potato in the pack would need to weigh around half a kilogram for the pack to be a better bargain.

Baking potatoes are big, but it's unlikely that a pack of three baking potatoes would weigh   kg.

[Back to - Activity 4](%22%20%5Cl%20%22Session1_Activity4)

## Example 4

#### Answer

If you have a calculator handy then you could key in 22 ÷ 7 to convert to a decimal. However, if not, you might use long division or an informal method of division. Either way you should get 3.1428 …. So  agrees to 3 significant figures.

You will probably find it easier to use a calculator for dividing 355 by 113. The result is 3.14159292, which agrees to 7 significant figures.

Sometimes you are given a ratio as a decimal, but might find it easier to use and/or remember as a fraction.

[Back to - Example 4](%22%20%5Cl%20%22Session1_Example4)

## Example 5

#### Answer

Start of $1



End of $1

This fraction is an adequate answer, or you can divide top and bottom by common factors to reach a simpler equivalent fraction.

Divide top and bottom by 5 to get .

Divide top and bottom by 5 again to get .

Divide top and bottom by 5 again to get .

So the fraction is , which is the fraction used earlier.

An alternative method is do this in one line cancelling 

[Back to - Example 5](%22%20%5Cl%20%22Session1_Example5)

## Activity 5

#### Answer

* (a) = 0.2
* (b)  = 0.3333 ... this repeats indefinitely. As a decimal, you need to terminate after some finite number of places, e.g. 0.3333 to four decimal places.
* (c)  = 1.5
* (d)  = 2.25

Alternatively, 2 is 2.00,  is 0.25, and adding them together gives 2.25.

[Back to - Activity 5](%22%20%5Cl%20%22Session1_Activity5)

## Activity 6

#### Answer

* (a) 0.25 = 
* (b)1.135 = 
* (c)0.064 = 

[Back to - Activity 6](%22%20%5Cl%20%22Session1_Activity6)

## Activity 7

#### Answer

You need to multiply  by . First convert to top-heavy fractions or decimals:

Start of $1



End of $1

Follow-up in Section 3.1.2

Alternatively 2.5 × 1.75 = 4.375.

So  or 4.375 litres of water is required.

[Back to - Activity 7](%22%20%5Cl%20%22Session1_Activity7)

## Example 6

#### Answer

* (a) To find the speed in miles per hour, you need the ratio of the distance in miles to time in hours. In 223 seconds (3 minutes 43 seconds) he ran 1 mile. Therefore in 1 second he would run 1/223 miles. In 3600 seconds (i.e. 1 hour), he would run 3600/223 miles i.e. 16.14 miles (to 2 d.p.). So the athlete's speed is 16.14 miles per hour (to 2 d.p.).
* (b) Hicham ran 1500 metres in 3 minutes 26 seconds (i.e. 206 seconds), so he ran  metres in 1 second. In 3600 seconds (1 hour) he runs 3600 ×  metres. That is, 26 213.59 metres per hour. To convert to kilometres: divide by 1000 which gives 26.21 km per hour (to 2 d.p.).
* (c) To compare speeds in different units, you need to convert one to the other, say miles per hour to kilometres per hour. Since 1 mile is 1.61 km, 16.14 miles is 16.14 × 1.61 = 25.99 km (to 2 d.p.). Hence 16.14 miles per hour is the same as 25.99 km per hour. This is a lower speed than 26.21 km per hour. So Hicham ran the 1500 metre race faster, which is not surprising as it is a shorter distance.

[Back to - Example 6](%22%20%5Cl%20%22Session1_Example6)

## Activity 8

#### Answer

There are at least three ways of answering this:

* (a) 70 seconds is  = 1.1666 ... minutes, which is less than 1.2 minutes.
* (b) 1.2 minutes is  =  minutes. 70 seconds is 1 minute 10 seconds, i.e.  =  minutes. Since  is less than , 70 seconds is less than 1.2 minutes.
* (c) 1.2 minutes is 1.2 × 60 = 72 seconds, which is greater than 70 seconds.
* So 1.2 minutes is greater than 70 seconds.

[Back to - Activity 8](%22%20%5Cl%20%22Session1_Activity8)

## Activity 9

#### Answer

* (a) Speed is the ratio of distance travelled to time taken, which in the cheetah's case is 400 metres to 15 seconds. So its speed is    27 metres per second (to 2 s.f.).

To determine this speed in kilometres per hour, both units need changing.

* 400 metres are  kilometres
* 15 seconds are  hours.
* So  in the new units is

Start of $1



End of $1

* So the cheetah's speed is 96 kilometres per hour (over a distance of 400 metres).
* (b) In 16 hours the sloth moves 1 mile.
* It will take 5 × 16 = 80 hours to move 5 miles which is 8 km.
* So it will take 80 hours to move 8 km.
* In 1 hour it will move 8/80 km or 0.1 km.
* So the sloth will move at a speed of 0.1 km/h (assuming it does not fall asleep!).
* To convert this speed to metres per second,
* 0.1 km is 100 metres
* 1 hour is 3600 seconds
* So speed is 0.028 metres per second (to 2 s.f.)

[Back to - Activity 9](%22%20%5Cl%20%22Session1_Activity9)

## Activity 10

#### Answer

As a fraction of an hour, 11 minutes is 11/60 hours.

To convert this to a decimal, divide 11 by 60 to get 0.18333….

This is greater than 0.17, so 11 minutes is longer.

(Alternatively, 0.17 hours is 60 × 0.17 = 10.2 minutes, so 11 minutes is longer.)

[Back to - Activity 10](%22%20%5Cl%20%22Session1_Activity10)

## Activity 11

#### Answer

* (a)
	+ (i) In 1 hour the van travels 50 km so in  hours the van travels 50 ×  = 125 km.
	+ (ii) The van travels 50 km in 1 hour so it travels 1 km in  hour. It therefore travels 160 km in 160 ×  hours, i.e.  hours or  hours (3 hours 12 minutes).
* (b)
	+ (i) 70 × = 175 km.
	+ (ii) 2.29 hours (2 hours 17 minutes).

[Back to - Activity 11](%22%20%5Cl%20%22Session1_Activity11)

## Example 7

#### Answer

There are several ways to do this. Here is one.

3 cats eat 2 tins a day

1 cat eats  tin a day

4 cats eat  tins a day

4 cats eat  tins a week

So John should buy 19 tins for the week.

Note it helped to simplify the problems by considering 1 cat, rather than going straight to 4 cats.

[Back to - Example 7](%22%20%5Cl%20%22Session2_Example1)

## Example 8

#### Answer

(a) 1 minute cost 30 p. (i.e. 60 seconds for 30 p).

* 1 second for  p = 0.5 p.
* 7 minutes 34 seconds is 454 seconds, costing 454 × 0.5 p = 227 p.
* The call should have been charged at £2.27.

(b) 0.5 p will allow her to talk for 1 second.

* 1 p will allow her to talk for 2 seconds.
* £2.50 (250 p) will allow her to talk for 250 × 2 seconds, = 500 seconds, i.e. 8 minutes 20 seconds.

[Back to - Example 8](%22%20%5Cl%20%22Session2_Example2)

## Activity 12

#### Answer

For one person you need   teaspoons.

For ten people you need   teaspoons.

So almost 2 teaspoons of mustard are needed.

[Back to - Activity 12](%22%20%5Cl%20%22Session2_Activity1)

## Activity 13

#### Answer

If it takes 5 hours to cook  kg then the time to cook 1 kg is 5 ÷  hours.

Start of $1



End of $1

So a 2 kg pudding takes   hours (6 hours 40 mins), assuming that cooking time is proportional to weight.

[Back to - Activity 13](%22%20%5Cl%20%22Session2_Activity2)

## Example 9

#### Answer

Take the same approach as in [Examples 7](#exa007) and [8](#exa008), and first work out how long it would take one person to deliver leaflets to the estate.

It will take one person five times as long as a team of five people. (If you find this hard to accept, imagine that the estate consists of five streets, and that each person delivers leaflets to one of these streets in the three hours.) So each street takes 3 hours to leaflet. It would take one person 5 × 3 hours to leaflet all five.

So it takes one person 15 hours to deliver leaflets to the whole estate. Two people will take half this time, so two people take  hours.

(As a check: you would expect two people to take longer than five.)

[Back to - Example 9](%22%20%5Cl%20%22Session2_Example3)

## Activity 14

#### Answer

C: 4 programmers take 1 year.

So 1 programmer would take 4 years.

3 programmers would take   years =   or 1 year 4 months.

[Back to - Activity 14](%22%20%5Cl%20%22Session2_Activity3)

## Activity 15

#### Answer

* (a) First work out how long it would last one person, remembering that it will last longer for one person:
* it lasts 1 week for 7 people, so it lasts 7 weeks for 1 person.
* It will last less than this for 2 people – you need to divide by 2: i.e. it lasts  weeks for 2 people.
* (b) You know that in  weeks 2 people get through 10 kg of potatoes, so in 1 week 2 people get through 10 ÷   2.86 kg. In practice you would probably buy 3 kg most weeks, and 2 kg when there seemed to be a lot of potatoes left over from the previous week.

[Back to - Activity 15](%22%20%5Cl%20%22Session2_Activity4)

## Activity 16

#### Answer

One worker should take twice as long as two. So 1 worker takes 40 mins for 500 labels. 4000 is 8 times 500 so 1 worker takes 40 × 8 min = 320 mins. 1 hour is 60 mins.

So you need  workers .

Practically, you could have 5 workers for  = 64 mins (just over an hour) or 6 workers for  = 53 mins (just under an hour).

[Back to - Activity 16](%22%20%5Cl%20%22Session2_Activity5)

## Example 10

#### Answer

They want to find 90% of £150 000. 90% =  = 0.9.

  0.9 × 150 000 = 135 000

So the Smiths would get £135 000.

[Back to - Example 10](%22%20%5Cl%20%22Session3_Example1)

## Activity 17

#### Answer

* (a) 40%= 
* (b) 8%= 
* (c) 70%= 
* (d) 

[Back to - Activity 17](%22%20%5Cl%20%22Session3_Activity1)

## Activity 18

#### Answer

* (a) 50% =  = 0.5
* (b) 85% = =0.85
* (c) 7% = = 0.07
* (d) 

[Back to - Activity 18](%22%20%5Cl%20%22Session3_Activity2)

## Activity 19

#### Answer

* (a) 75% of 840 = 0.75 × 840 = 630,
* so 630 women were in paid work.
* (b) 90% of 840 = 0.9 × 840 = 756,
* so 756 men were in paid work.
* (c) 18% of 840 = 0.18 × 840 = 151.2.
* But 151.2 is not a whole number. So 151 couples had a joint income of less than £160 per week. (The survey result must have been rounded, as a percentage, to the nearest whole number.)

[Back to - Activity 19](%22%20%5Cl%20%22Session3_Activity3)

## Example 11

#### Answer

2540 out of 5000 as a percentage is   × 100 = 50.8%

Swing = 50.8 − 42.1 = 8.7 percentage points.

[Back to - Example 11](%22%20%5Cl%20%22Session3_Example2)

## Activity 20

#### Answer

* (a)
	+ (i) 0.8 = 80%
	+ (ii) 0.21 = 21%
	+ (iii) 0.70 = 70%
	+ (iv) 2.4 = 240%
* (b)
	+ (i)   = 0.5= 50%
	+ (ii)   = 0.125=12.5%  13%
	+ (iii)     0.1111  11%
	+ (iv)     1.143  114%

[Back to - Activity 20](%22%20%5Cl%20%22Session3_Activity4)

## Activity 21

#### Answer

2100 out of 5000 is

× 100% = 42%.

The swing is 42 − 10 = 32 percentage points.

[Back to - Activity 21](%22%20%5Cl%20%22Session3_Activity5)

## Example 12

#### Answer

Adding VAT first gives 100% +  = 

   of £76 = 1.175 × £76 = £89.30

Adding the service charge on to £89.30 gives 100% + 15% = 115%

  115% of £89.30 = 1.15 × £89.30 = £102.70 (correct to the nearest penny).

So the total bill is £102.70.

Adding these extras the other way round:

  115% of £76 = 1.15 × £76 = £87.40;

   of £87.40 = 1.175 × £87.40

   = £102.70 (correct to the nearest penny).

In the first case 1.15 × 1.175 × £76, and in the second 1.175 × 1.15 × £76. The order doesn’t matter in multiplication: 1.175 × 1.15 = 1.15 × 1.175.

The total bill is the same. The order does not matter from the customer's point of view. However, it does from the VAT collector's point of view (and indeed from that of the restaurant management, who receive a bigger service charge if it is calculated last). If VAT is added first, VAT is  of £76. If VAT is added last, VAT is  of £87.40. Hence legally VAT must be added last!

[Back to - Example 12](%22%20%5Cl%20%22Session3_Example3)

## Activity 22

#### Answer

* (a)  of £35.75 = 1.175 × £35.75 = £42.006 25. In practice this would be rounded to the nearest penny, i.e. £42.01 (or £42.00 perhaps).
* (b) A 10% discount would reduce it to 90% of its previous selling price, i.e. 0.9 × £35.75 = £32.175  £32.18.
* (c) If VAT is added first you get 0.9 × £42.01 = £37.809  £37.81. If the discount is taken first you get 1.175 × £32.18 = £37.8115  £37.81. Thus it makes no difference to the final price whether you take the discount or the VAT first. The reason for this is, essentially, that the order in which you do successive multiplication doesn’t matter:
* 0.9 × 1.175 × 35.75 = 1.175 × 0.9 × 35.75

[Back to - Activity 22](%22%20%5Cl%20%22Session3_Activity6)

## Activity 23

#### Answer

If increase on fares is 7.4% then you would need to find

  (100% + 7.4%) i.e. 107.4% of £1260.

  1.074 × 1260 = 1353.24.

So the season ticket will cost £1353.24 after the increase.

[Back to - Activity 23](%22%20%5Cl%20%22Session3_Activity7)

## Example 13

#### Answer

* (a) In the first sale the Chinese rug would cost (100% − 20%) of £245, 100% − 20% = 80%, 0.80 × £245 = £196.
* (b) In the final closing sale the rug would cost (100% − 12%) of £196 or 0.88 × £196 = £172.48.

[Back to - Example 13](%22%20%5Cl%20%22Session3_Example4)

## Activity 24

#### Answer

A 12% decrease would reduce it to 88% of the original time, i.e. 0.88 × 90 = 79.2 minutes.

0.2 of a minute = 0.2 × 60 = 12 secs.

So 79.2 minutes = 79 minutes and 12 secs.

[Back to - Activity 24](%22%20%5Cl%20%22Session3_Activity8)

## Activity 25

#### Answer

* (a) Population after 1 year is likely to be
* (100% − 4%) of 4650,
* i.e. 96% of 4650,
* which is 0.96 × 4650 = 4464 people.
* (b) Population after 2 years is likely to be
* 96% of 4464,
* i.e. 0.96 × 4464 = 4285.44 people,
* but you can’t have 0.44 of a person. So approximately 4285 people.

[Back to - Activity 25](%22%20%5Cl%20%22Session3_Activity9)

## Example 14

#### Answer

* (a) Casualties would be 100% + 8% of 1920, that is, 108% of 1920.
* This gives 1.08 × 1920 = 2073.6 = 2074 (correct to nearest whole number) as a prediction for the number of casualties next year.
* (b) Repeat this calculation again on next year's figures to find the predicted figure for the number of casualties in two years' time.
* This is 108% of 2074. 1.08 × 2074 = 2239.92  2240 casualties.

[Back to - Example 14](%22%20%5Cl%20%22Session3_Example5)

## Activity 26

#### Answer

* (a)  40% =   =  .
* (b)   =   × 100% = 3 × 25% = 75%.
* (c) 1.26 = 1.26 × 100% = 126%.

[Back to - Activity 26](%22%20%5Cl%20%22Session3_Activity10)

## Activity 27

#### Answer

× 100% = 41.6%.

The swing is 41.6 − 35.1 = 6.5 percentage points.

[Back to - Activity 27](%22%20%5Cl%20%22Session3_Activity11)

## Activity 28

#### Answer

* (a) £2200 × = £2585.
* (b) £2585 ×  = £2326.50.

[Back to - Activity 28](%22%20%5Cl%20%22Session3_Activity12)

## Activity 29

#### Answer

The London to Geneva fare is increased by 17%. So it will now cost 117% of £165, i.e. 1.17 × £165 = £193.05.

The London to New York fare is increased by 15%. So it will now cost 115% of £376, i.e. 1.15 × £376 = £432.40.

[Back to - Activity 29](%22%20%5Cl%20%22Session3_Activity13)

# Uncaptioned Figure

## Description

2 written clothes label with the text '100% cotton' and '60% cotton, 40% polyester'

[Back to - Uncaptioned Figure](%22%20%5Cl%20%22Session3_Figure1)

# Uncaptioned Figure

## Description

Tennis racket next to a folded card with the text 'only £35.75 +VAT'

[Back to - Uncaptioned Figure](%22%20%5Cl%20%22Session3_Figure2)