Learning Enhancement Team

University of East Anglia

STUDENT SUPPORT SERVICE

Steps into Numeracy

Ratio

This guide helps you to understand, calculate and manipulate ratios.

Introduction

Ratios are very common in basic numerical calculations and they are the way that mathematics describes dividing something up into parts. Ratios also compare the relative amounts of those parts. For example you may want to describe how to divide £500 between three people Robert, Gordon and Athina. You may want to give 3 parts, Gordon 2 parts and Athina 5 parts. This means that for every £3 Robert gets, Gordon gets £2 and Athina gets £5. Ratios are written using a colon ":" and so this ratio is written:

$3:2:5$ Say "ratio of two to three to five"

You could also think of the ratio as meaning that for every £10, Robert gets £3, Gordon gets £2 and Athina gets £5. So Robert gets 3 out of every 10, Gordon gets 2 out of every 10 and Athina gets 5 out of every 10. By thinking about the ratio this way you can calculate how much of the £500 each person gets by scaling the ratio up from one which describes £10 to one which describes £500 (by multiplying by 50). Doing this the ratio becomes:

$3:2:5$ multiply by 50 $150:100:250$

Notice that you get 500 when you add together the parts in the scaled up ratio and this tells you that Robert gets £150 of the £500, Gordon gets £100 and Athina gets £250.

A more mathematical approach

You can take a more mathematical approach to calculating ratios which will work when the numbers involved are a bit more difficult than those in the example above.

1. Add together the parts of the ratio.
2. Divide each ratio part by the number found in step 1. This gives a new ratio.
3. Multiply each of the new ratio parts by the amount you are dividing up.

Let's apply this to the example in the introduction.

Example: Divide £500 into the ratio $3:2:5$.

1. Adding together the parts of the ratio gives $3+2+5=10$.
2. Dividing each of the ratio parts by 10 gives $\dfrac{3}{10}:\dfrac{2}{10}:\dfrac{5}{10}$.
3. Multiplying this new ratio by £500 gives $£150:£100:£250$

which is the answer you saw in the introduction. **You should always check your answer by adding together the result to see if you get the right amount.** You can also see from step 2 that ratios are another way of thinking about fractions. The study guide: *Multiplying and Dividing Fractions* can help with understanding step 3.

Example: Divide 1026 into the ratio $8:19$.

1. Adding together the parts of the ratio gives $8+19=27$.
2. Dividing each of the ratio parts by 27 gives $\dfrac{8}{27}:\dfrac{19}{27}$.
3. Multiplying this new ratio by 1026 gives $304:722$

So 1026 divided into the ratio $8:19$ is $304:722$. (Check $304+722=1026$).

Simplifying ratios

You can **simplify** a ratio where a factor is common in all of the parts by dividing through by that common factor. The study guide: *Prime Factors* illustrates methods to help you identify common factors. Importantly:

> **Dividing each part of a ratio by the same number will not alter the ratio**.
>
> **Multiplying each part of a ratio by the same number will not alter the ratio**.

Simplifying a ratio can be beneficial as you will have smaller numbers to work with in your calculations.

Example: Divide £500 into the ratio $15:10:25$.

Notice that the parts of the ratio have a common factor of 5 (as 5 divides 15, 10 and 25). Dividing each part of the ratio by 5 gives $3:2:5$ which reveals that the question is the same as that in the previous section. It is easier to work with 3, 2 and 5 rather than 15, 10 and 25.

Example: Allocate 6600 photocopies in the ratio $216 : 168 : 12$.

Notice that the parts of the ratio have a common factor of 12 (as 12 divides 216, 168 and 12). Dividing each part of the ratio by 12 gives $18 : 14 : 1$

Now following the steps laid out earlier in this guide:

1. Adding together the parts of the ratio gives $18 + 14 + 1 = 33$.

2. Dividing each of the ratio parts by 5 gives $\dfrac{18}{33} : \dfrac{14}{33} : \dfrac{1}{33}$.

3. Multiplying this new ratio by 6600 gives $3600 : 2800 : 200$.

So 6600 photocopies divided into the ratio $216 : 168 : 12$ is:

      3600 photocopies : 2800 photocopies : 200 photocopies.

(Check $3600 + 2800 + 200 = 6600$).

Sometimes you will see ratios which are described in terms of fractions. For example you may be asked to allocate 120 minutes into the ratio $\frac{1}{2} : \frac{1}{3}$. These types of questions can seem difficult but the key to solving them is to simplify the ratio by multiplying by the **lowest common multiple** of the denominators of the fractions (see study guide: *Lowest Common Multiple*) this will re-express the fractions as whole numbers and make the ratio easier to work with.

Example: Allocate 120 minutes into the ratio $\frac{1}{2} : \frac{1}{3}$.

The lowest common multiple of 2 and 3 is 6. Multiplying the ratio by 6 gives:

      $\frac{1}{2} : \frac{1}{3}$ multiply by 6 to give $3 : 2$

Now you can follow the steps laid out earlier in this guide:

1. Adding together the parts of the ratio gives $3 + 2 = 5$.

2. Dividing each of the ratio parts by 5 gives $\dfrac{3}{5} : \dfrac{2}{5}$.

3. Multiplying this new ratio by 120 gives $72 : 48$.

So 120 minutes divided into the ratio $\frac{1}{2} : \frac{1}{3}$ is:

      72 minutes : 48 minutes   (Check $72 + 48 = 120$).

Using ratios in other ways

You can use the idea of a ratio to help you solve many problems in science and economics. For example calculating drug doses and concentrations can be formulated as a ratio. If a tablet has 250 mg of a drug in it you could describe this information as the ratio $250:1$ (250mg in one tablet). As you saw in the previous section, if you multiply or divide a ratio by a constant it remains the same so:

$500:2$ (multiplying by 2 tells you there are 500mg in 2 tablets)
$1000:4$ (multiplying by 4 tells you there are 1000 mg in 4 tablets)

And so on.

Example: If a solution has 5mg of drug in 2 ml, how much drug is in 10 ml?

First set up the ratio $5:2$ (5mg of drug in 2ml). You now need to multiply by 5 to make the 2ml you have into the 10 ml you need to know about.

$25:10$ (multiplying by 5 tells you there are 25mg in 10ml)

So 10ml of the solution contains 25ml of the drug.

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.

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- 🖥   Ask: ask.let@uea.ac.uk
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