Applied Math for Food Service

APPLIED MATH FOR FOOD SERVICE

NSCC MATH 1020

NSCC AND THE BC COOK ARTICULATION COMMITTEE

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NSCC

Nova Scotia

CONTENTS

PREFACE

One of the most important aspects of being successful in the food service industry is being able to manage costs. Without managing costs, none of the businesses you might work for over the course of your career would remain open. In this book, we explore the fundamentals of kitchen management from the basic math and calculations you will need to use every day to an overview of the costs associated with operating a kitchen or any food service operation.

Basic Kitchen and Food Service Management is one of a series of *Culinary Arts* books developed to support the training of students and apprentices in BC's food service and hospitality industry. Although created with the professional cook, baker, and meat cutter programs in mind, these books have been designed as a modular series and therefore can be used to support a wide variety of programs that offer training in food service skills.

Other books in the series include:

- Food Safety, Sanitation, and Personal Hygiene
- Working in the Food Service Industry
- Workplace Safety in the Food Service Industry
- Meat Cutting and Processing
- Human Resources in the Food Service and Hospitality Industry
- Understanding Ingredients for the Canadian Baker
- Nutrition and Labelling for the Canadian Baker
- Modern Pastry and Plated Dessert Techniques

The series has been developed collaboratively with participation from public and private post-secondary institutions.

ABOUT THE BOOK

Applied Math for Food Service is an adapted open textbook created by Amy Savoury.
This new open textbook remixes content from two open textbooks published by BC Campus under CC BY licences:

- Basic Kitchen & Food Service Management by The BC Cook Articulation Committee
- Math for Trades by Chad Flinn and Mark Overgaard

See the Versioning history chapter at the end of this book for more information.

UNIT 1 - THE METRIC SYSTEM

1.1 UNITS OF MEASUREMENT

Canadian cooks should feel comfortable working in three different measurement systems. Two of these systems (U.S. and imperial) are closely related, while the third (S.I., more commonly called metric) is different from the other two.

Although the metric system was introduced in Canada a number of years ago, the food industry and home cooks still rely heavily on equipment and cookbooks imported from the United States. In addition, because we used imperial measurements in Canada for the sale of liquids, some industry recipes will call for imperial measurements rather than U.S. liquid measurements.

The imperial and U.S. measuring systems evolved out of the system used in Europe prior to the 20th century. Although both the imperial and U.S. systems use the same terminology, there are slight differences in actual measurements that you must account for, particularly with **volume**.

The easiest way to work with the three systems is to have different sets of measuring devices: one for the metric system, one for the imperial system, and one for the U.S. system. Alternatively, you could have one set of devices that have measurements for all three systems indicated. U.S. measuring instruments can be used with slight adjustments for imperial measuring.

It is not good practice to use two systems of measurement when preparing a recipe. Working between two systems of measurement in a recipe may result in inaccuracies that could affect the final product's taste, yield, consistency, and appearance. To ensure a consistent and successful result, a good practice is to convert the recipe into one standard system of measurement.

THE S.I. (METRIC) SYSTEM: TYPES, UNITS, AND SYMBOLS

All measuring systems have basic units for length, mass (weight), capacity (volume), and temperature. The basic units for the metric system are shown in Table 1.

Table 1: Basic metric units

Type of Measurement	Unit	Symbol
length (distance)	metre	m
mass (weight)	gram	g
capacity (volume)	litre	L
temperature	degrees Celsius	°C

Note that the abbreviation or symbol of the unit is not followed by a period and that all the abbreviations are lowercase letters except for litre which is usually a capital *L*.

In the metric system, the basic units are turned into larger or smaller measurements by using a prefix that carries a specific meaning as shown in Table 2. The most commonly used prefixes are kilo (k), centi (c), and milli (m).

Table 2: Metric prefixes

Prefix	Symbol	Meaning
kilo	**k**	**1000**
hecto	h	100
deca	da	10
deci	d	1/10 or 0.1
centi	**c**	**1/100 or 0.01**
milli	**m**	**1/1000 or 0.001**

When you read a measurement in the metric system, it is fairly easy to translate the measurement into a number of the basic units. For example, 5 kg (five kilograms) is the same as 5 × 1000 (the meaning of kilo) grams or 5000 grams. Or 2 mL (two millilitres) is the same as 2 × 0.001 (the meaning of milli) litres or 0.002 litres. This process is discussed further in the section on converting below.

The most commonly used measurements in commercial kitchens are mass (weight), capacity (volume), and temperature.

UNITS OF LENGTH (DISTANCE)

The basic unit of length or distance in the metric system is the metre. The most frequently used units of length used in the Canadian food industry are the centimetre and millimetre. The units of length in the metric system are shown in Table 3.

Table 3: Metric units of length

Unit	Abbreviation	Length (Distance)
kilometre	km	1000 meter
hectometre	hm	100 metres
decametre	dam	10 metres
metre	m	1 metre
decimetre	dm	0.1 metres
centimetre	**cm**	**0.01 metres**
millimetre	**mm**	**0.001 metres**

UNITS OF MASS (WEIGHT)

The basic unit of mass or weight in the metric system is the gram. The most frequently used units of mass or weight used in the Canadian food industry are the gram and kilogram. The units of mass in the metric system are shown in Table 4.

Table 4: Metric units of mass (weight)

Unit	Abbreviation	Mass (Weight)
tonne	t	1000 kilograms
kilogram	**kg**	**1000 grams**
hectogram	hg	100 grams
decagram	dag	10 grams
gram	**g**	**1 gram**
decigram	dg	0.1 g
centigram	cg	0.01 g
milligram	mg	0.001

> **Note:** Certain metric terminology is not regularly used for ease of production and service. The average cook or chef will not remember how many grams there are in a hecto-, deca-, deci-, or centigram. It is much more practical to write and read 100 grams in a recipe than 1 hectogram.

UNITS OF CAPACITY (VOLUME)

The basic unit of volume or capacity is the litre. The most commonly used units in cooking are the litre and the millilitre. The units of volume in the metric system are shown in Table 5.

Table 5: Metric units of volume

Unit	Abbreviation	Volume
kilolitre	kL	1000 L
hectolitre	hL	100 L
decalitre	daL	10 L
litre	**L**	**1 L**
decilitre	dL	0.1 L
centilitre	cL	0.01 L
millilitre	**mL**	**0.001 L**

Occasionally, you will encounter a unit of volume called cubic measurement (sometimes used to express the volume of solids or the capacity of containers), and the units will be expressed as “cc” or cm^3 (cubic centimetre). Cubic centimetres are the same as millilitres. That is, 1 cc = 1 cm^3 = 1 mL

In the metric system, 1 mL (cc) of water weighs 1 gram. We will explore this later when discussing the difference between measuring by weight and by volume.

1.2 TEMPERATURE

The metric units for temperature are degrees Celsius (°C). There are no other units used. Temperature is one area where you may find it necessary to convert from Celsius to Fahrenheit and vice versa, as you probably do not have two ovens or stoves at your disposal. However, many modern stoves and ovens, as well as most thermometers, have both Celsius and Fahrenheit temperatures marked on their controls.

Note: There are many “apps” available for converting measurements. These can easily be downloaded onto a smartphone or tablet and used in the kitchen.

1.3 CONVERTING WITHIN THE METRIC SYSTEM

To convert from one unit to another within the metric system usually means moving a decimal point. If you can remember what the prefixes mean, you can convert within the metric system relatively easily by simply multiplying or dividing the number by the value of the prefix.

The most common metric measurements used in the food service industry are kilograms, grams, litres, and millilitres.

EXAMPLES OF HOW TO CONVERT BETWEEN MEASUREMENTS

Example 1

Convert 26.75 kg to g.

First, write the question with the meaning of the prefix inserted. In this example, *k* is the prefix, and *k* means 1000, so:

26.75 kg = 26.75 × (1000) g = 26 750 g

Notice that there is no comma used in the answer 26 750 g. In the metric system, large numbers are separated every three digits by a space, not a comma.

Example 2

Convert 0.2 L to mL.

Again, write the question with the meaning of the prefix inserted. In this example, m is the prefix, and m means 0.001, so:

0.2 L = _____ (0.001) L

To find the blank (the value of the millilitres), divide the left-hand number by the right-hand number.

0.2 L ÷ 0.001 L = 200

This means 0.2 L = 200 mL.

Notice that there is a zero (0) before (to the left of) the decimal point. When writing decimal numbers that are smaller than 1 in the metric system, it is customary to place a zero to the left of the decimal point. Thus .6 in the metric system is written 0.6.

If you are working with two prefixes, you can convert in much the same way as above.

Example 3

Find the number of dL in 12.2 mL.

The prefixes are *d,* which means 0.1, and *m*, which means 0.001. Insert the values of the prefixes into the conversion.

______ dL = 12.2 mL

______ (0.1) L = 12.2 (0.001) L

______ (0.1) L = 0.0122 L

To find the value of the blank, divide the right-hand number by the left-hand number.

0.0122 L ÷ 0.1 L = 0.122

This means that 12.2 mL = 0.122 dL.

MATH FOUNDATION FOR UNIT 1: WHOLE NUMBERS

1.E DIVIDING WHOLE NUMBERS

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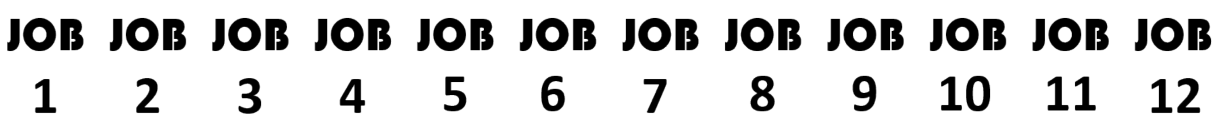
Harpreet has ended up with a total of 12 jobs on the go. He has decided to hire 3 more people to help him with all the work. They are Dixon, Kavanir, and Arman. He now has 4 employees including Jamieson and he splits the jobs evenly between the 4 of them. How many jobs will each of them be doing?

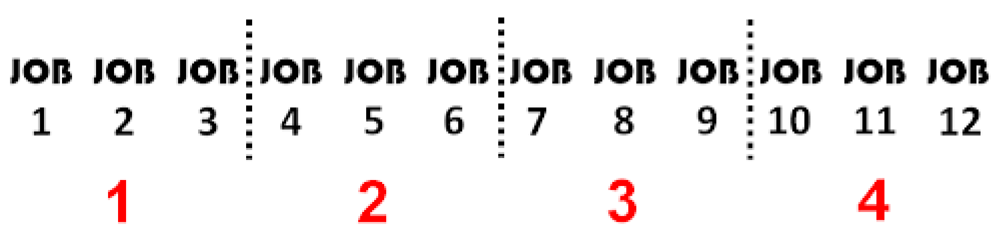
This would be an example of dividing whole numbers. Harpreet has a total of 12 jobs and he has 4 employees splitting the number of jobs evenly. We would write this as:

$$12 \div 4 = ?$$

How would we go about solving this? Well let's look at it visually to start. We have 12 jobs to work with.



What we do now when dividing is take the number we have (12) and split it into the number of groups we are going to have. In this case we have 4 employees so we will split it into 4 even groups.

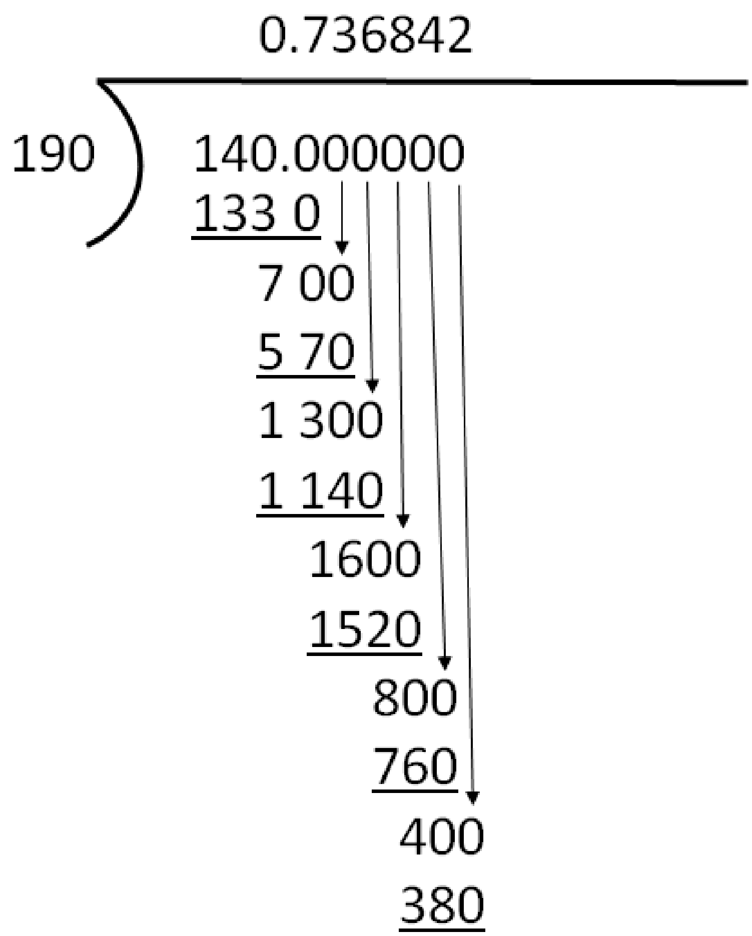


You can now count that there are 3 jobs in every group. So what we get in the end is:

$$12 \div 4 = 3$$

Like multiplying, dividing small whole numbers is usually pretty straight forward. But what if we had a case where we have larger numbers. How would you go about doing this calculation without the use of a calculator?

What we use is a system called "LONG DIVISION" and it looks something like the following:



Example

We'll use this process of long division to answer the following question. How many times does 5 go into 90?

Step 1: Set up the equation in a workable form.

Note: the symbol to the left is used to designate a long division question. The placement of the five in the equation indicates that it is the number to be divided into the 90. Essentially, the equation is asking how many times 5 can go into 90.

Step 2: Take the 5 and divide it into the first digit in the number to be divided into. In this case this is the 9. We have to figure out how many times 5 goes into 9 without going over.

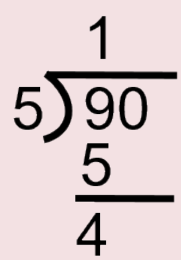
This is where knowing our times tables really comes in handy. We know that:

$$5 \times 1 = 5$$

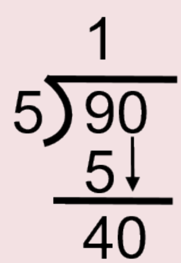
and

$$5 \times 2 = 10$$

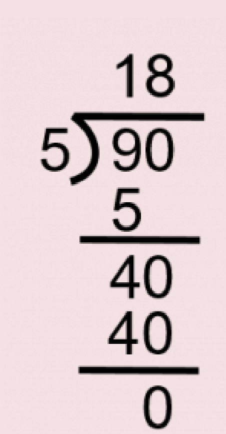
Therefore we know that 5 goes into 9 one complete time with 4 left over.



To complete this step we need to bring down the next number in the equation. In this case, it's the 0. What we have now is 40 and the next step becomes how many times 5 goes into 40.



Step 3: Figure out how many times 5 goes into 40 without going over. If we go back to our multiplying, we might be able to remember that 5 goes into 40 exactly 8 times.



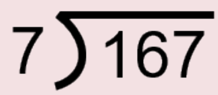
As we end up with zero there are no more numbers to work with through which means we are done.

Try another example.

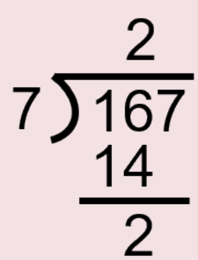
Example

How many times does 7 go into 167?

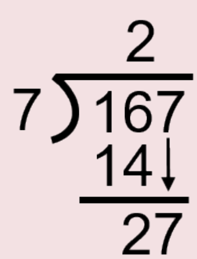
Step 1: Set up the equation in a workable form.



Step 2: Take the 7 and divide it into the first digit in the number to be divided into. In this case this is the 1, and we can see that this is not going to work. As such, we just move one step to the right and divide the 7 into 16.



To complete this step we need to bring down the next number in the equation. In this case it's the 7. We now have 27 and the next step becomes how many times 7 goes into 27.



Step 3: Figure out how many times 7 goes into 27 without going over.

$$\begin{array}{r} 23 \\ 7\overline{)167} \\ \underline{14} \\ 27 \\ \underline{21} \\ 6 \end{array}$$

We end up with a little different scenario here than in the first question. When we get to the end of the question we have 6 left over. What this is telling us is that 7 goes into 167 twenty three times with 6 left over.

PRACTICE QUESTIONS

Try a couple example questions yourself and check the video answers to see how you did. Remember to set the question up in a format that works.

Question 1

$$130 \div 8 =$$

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://pressbooks.nscc.ca/foodmath/?p=169

Question 2

$$684 \div 12 =$$

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://pressbooks.nscc.ca/foodmath/?p=169

1.D MULTIPLYING WHOLE NUMBERS

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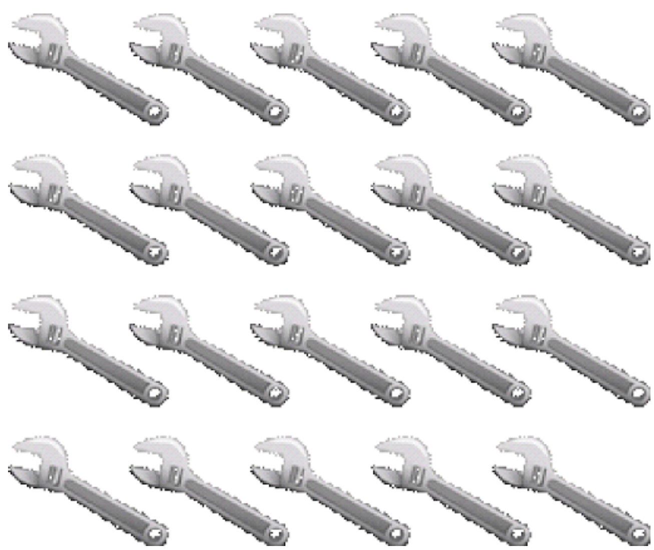
MULTIPLYING SMALL WHOLE NUMBERS

As Harpreet's company grows, he need to buy work vans for himself and his employees. He's able to get a deal and buys 4 vans. Each of those vans needs to be equipped with tools, so he starts with wrenches. He decides that each van needs 5 wrenches. How many wrenches would that be in total?

This is an example of multiplying whole numbers. The way we could sound it out or write it is as follows:

$$\text{Four times five OR } 4 \times 5$$

If we looked at it from a more visual perspective, it would look like this:



In this case we could physically count up all the wrenches, and we would end up with 20. We could also count up each row of 5 and add them as follows:

$$5 + 5 + 5 + 5 = 20$$

Or we could take one row of 5 and multiply it 4 times because there are 4 rows. The equation would look like this:

$$4 \times 5 = 20$$

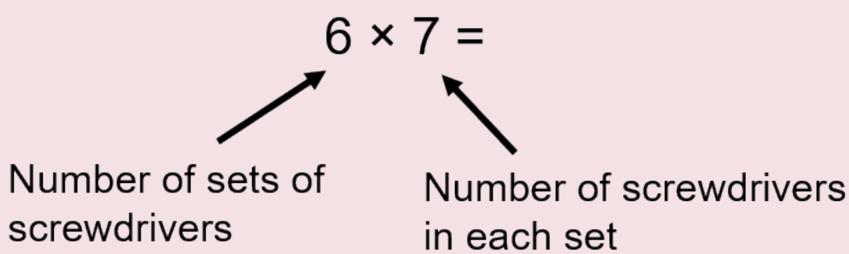
Each method should get us the same answer, but going 4 times 5 gets us to the answer quicker. If we were to multiply larger numbers such as 8 time 9 (8 × 9), we could spend a long time counting wrenches or a long time adding numbers. Multiplication simplifies the process.

Before moving on to multiplying larger numbers, why don't we go through another example of multiplying smaller numbers and use visuals to help us with our answer.

Example

Harpreet decides to buy some screwdrivers for the van and decides that each van needs 7 screwdrivers. He also decides to buy 2 extra sets for the shop. In total he decides to buy 6 sets of screwdrivers.

The first thing we should do is write the question in a form that we can work with.



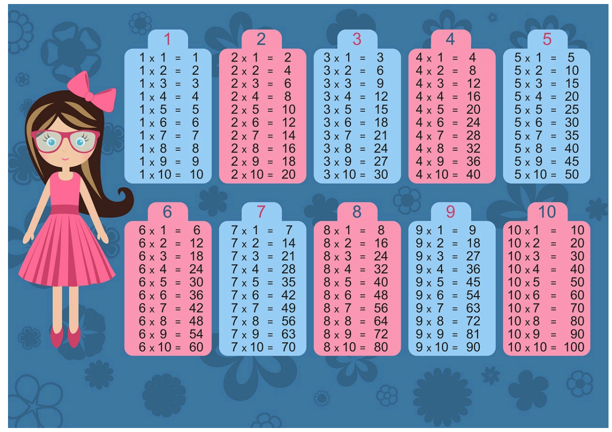
Remember you can also think of it like this:

$$7 + 7 + 7 + 7 + 7 + 7 =$$

And once again we could look at it visually and count up the screwdrivers.

If we were to count them up, we would find that we have 42 screwdrivers. If we took our calculator and plugged in 6 times 7, we would get the same answer. If we added 7 plus 7 plus 7 and so on, we would also end up with 42.

Now, we don't want to have to go through all that work of counting screwdrivers every time we multiply small numbers together. What students end up doing is using their calculator or just memorizing their "times tables." Times tables are a list of numbers being multiplied, starting at 1 times 1 and going up to 12 times 12. Take a look at the picture to the left to get and idea of what I'm talking about here. The idea is that you memorize these time tables so that when you see small numbers being multiplied, you can just access your memory for the answer.



A list of times tables for the numbers 1 to 10. Click on the image to see it full size or refer to the Appendix A: Times Tables chapter at the back of the book for a full list.

Although memorizing your times tables is great for small numbers, you still will run up against multiplying larger numbers. The following explanation goes through how we tackle this issue from a mathematical viewpoint.

MULTIPLYING LARGE WHOLE NUMBERS

Suppose that we want to multiply large numbers together. How do you think that would be done? The following method is used to calculate large whole numbers, and we're going to go right to an example complete with the steps for this one as its quite the process, and we really don't want to go through this twice.

What is the product of four hundred and thirty seven times three hundred and ninety two?

The word "product" in math terms means the multiplying of two numbers together.

One thing to keep in mind is that the process we are going to work our way through here takes some time and is a lot of work. If during the process you are asking yourself, *Would it be easier to just use a calculator?,* you would have a good case. But the point of this exercise is once again to help with our understanding of how numbers go together. Remember that once you understand the basics of math, the more difficult concepts will be handled more easily. Taking the time now to fully understand the concept will help you down the road and save you money down that same road.

Example

$$437 \times 392 = ?$$

Step 1: As always, the first step is to put the question in a format that is easy to work with.

$$\begin{array}{r} 437 \\ \times\ 392 \\ \hline \end{array}$$

The procedure is generally just multiplying a bunch of smaller numbers together to finally get the larger number. This is where knowing your times tables really comes in handy. The number on the bottom of the equation (in this case 392) is going to be worked with and changed much more than the upper number (437).

Step 2: We start the process by acting as if we are just multiplying the 437 by 2, the number in the ones column. So think of it as looking like the equation below.

$$\begin{array}{r} 437 \\ \times\quad 2 \\ \hline \end{array}$$

How this works is that you will first take the 2 and multiply it by the 7, then the 2 will be multiplied by the 3, and finally the 2 will be multiplied by the 4. Now this doesn't all occur in one step. Take a look below to see how this is done.

To start with, multiply the 2 by the 7 to get 14 **(2 × 7 = 14)**.

Enter the 4 into the "ones" column and carry the 1. Remember carrying the one? As the number 14 is too large to be put into the ones column, we have to take the extra and carry it into the next calculation with the tens column.

$$\begin{array}{r} {\scriptstyle 1} \\ 437 \\ \times\quad 2 \\ \hline 4 \end{array}$$

Step 3: Now multiply the 2 by the 3 to get 6. The 1 that we just carried is then added to the 6 to get 7. Put this answer in the tens column **(2 × 3 + 1 = 7)**.

$$\begin{array}{r} {\scriptstyle 1} \\ 437 \\ \times\quad 2 \\ \hline 74 \end{array}$$

Step 4: Take the 2 and multiply it by the 4 to get 8. Put this number in the hundreds column **(2 × 4 = 8)**.

$$\begin{array}{r} {\scriptstyle 1} \\ 437 \\ \times \quad 2 \\ \hline 874 \end{array}$$

Note: 874 is not the final answer. We still have a few steps to go. Once again you might be asking yourself if doing this with a calculator would be easier, and you'd be correct. It would be way easier but working through the question using this method will help you visualize the process behind multiplication.

Also, before you move on, take a second and go back through the initial steps. Make sure you understand the process we just went through.

Step 5: The next step would be to do the same thing with the number in the tens column. In this case, the 9. Think of it as looking at the equation like the one below.

$$\begin{array}{r} 437 \\ \times \quad 9 \\ \hline \end{array}$$

Note the empty space beside the 9. When we begin to take the 9 and multiply it by the number 437, this empty space in the ones column beside the 9 must be taken into account. This is done by placing a zero to start the process and placing it in the ones column. It would look something like is shown below.

$$\begin{array}{r} 437 \\ \times \quad 9 \\ \hline 874 \\ 0 \end{array}$$

Step 6: Now go ahead and multiply the 9 by all three numbers in the top portion of the equation, starting with the 7. When we take the 9 and multiply it by the 7, we get 63. The 3 is placed in the tens column below the 7 and then carry the 6 **(9 × 7 = 63)**.

$$
\begin{array}{r}
{\scriptstyle 6} \\
437 \\
\times \quad 9 \\
\hline
874 \\
30
\end{array}
$$

Step 7: Next multiply the 9 by the 3 to get 27. We then add the 6 that was carried over to get 33. The 3 goes in the hundreds column below the 8 and the other 3 is carried into the hundreds column to be used in the next calculation**(9 × 3 + 6 = 33)**.

$$
\begin{array}{r}
{\scriptstyle 3\;6} \\
437 \\
\times \quad 9 \\
\hline
874 \\
330
\end{array}
$$

Step 8: The 9 is then multiplied by the 4 to get 36. Then add the 3 that was carried over to get 39. As this is the last calculation for this part, put the 3 and the 9 into the answer. **(9 × 4 + 3 = 39)**

$$
\begin{array}{r}
{\scriptstyle 3\;6} \\
437 \\
\times \quad 9 \\
\hline
874 \\
39330
\end{array}
$$

Now do the same procedure using the 3 from the number 392. As the 3 is from the hundreds column, it can be thought of as looking at the equation below. Once again, in the answer we have to account for the fact that we are using a number in the hundreds column and add two zeros in the answer to start off the process.

Step 9: Take the 3 and multiply it by the 7 to get 21. Repeat the same procedure as before **(3 × 7 = 21)**.

$$\begin{array}{r} {\scriptstyle 2} \\ 437 \\ \times 3 \\ \hline 874 \\ 39330 \\ 100 \end{array}$$

Step 10: Now take the 3 and multiply it by the 3 to get 9 and add the 2 carried over from the first multiplication. This will give you 11 **(3 × 3 + 2 = 11)**.

$$\begin{array}{r} {\scriptstyle 1\,2} \\ 437 \\ \times 3 \\ \hline 874 \\ 39330 \\ 1100 \end{array}$$

Step 11: Take the 3 and multiply it by the 4 to get 12. Add the 1 to get 13 **(3 × 4 + 1 = 12)**.

$$\begin{array}{r} {\scriptstyle 1\,2} \\ 437 \\ \times 3 \\ \hline 874 \\ 39330 \\ 131100 \end{array}$$

Step 12: Finally, add up the 874, the 39,330 and the 131,100 together to get your final answer.

$$\begin{array}{r} 874 \\ 39330 \\ 131100 \\ \hline 171304 \end{array}$$

You might want to do a few things at this point. One is take a break and relax. That was a lot of work to go through. Take a minute to visually work through the process in your mind. If you feel you need to, go back through the work again and make sure you understand what is going on.

The second thing you might want to do at this point is check the answer using a calculator. Plug the numbers in and see what you get.

$$437 \times 392 = 171,304$$

PRACTICE QUESTIONS

Try a couple example questions yourself, and check the video answers to see how you did. Remember that this is a long process so take your time and pay attention to detail.

Question 1

$$\begin{array}{r} 522 \\ \times 196 \\ \hline \end{array}$$

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://pressbooks.nscc.ca/foodmath/?p=154

Question 2

$$\begin{array}{r} 647 \\ \times 381 \\ \hline \end{array}$$

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://pressbooks.nscc.ca/foodmath/?p=154

1.C SUBTRACTING WHOLE NUMBERS

CHAD FLINN AND MARK OVERGAARD

As his company grows, Harpreet asks Jamieson to bid on more jobs. Harpreet has had to hire a few plumbers to help with the work, as things are going well for the business and profits are climbing. It's going so well that they have had to turn down some of the jobs they are bidding on (and getting).

In fact, last month, they bid on 17 jobs and got all of them. They didn't figure they would get all 17 and actually had to turn down 5 of the jobs, leaving them with 12 jobs. This is an example of subtracting whole numbers.

The key to subtracting whole numbers is to find the difference between the two numbers. If we started with 17 jobs, and Harpreet turned down 5 of those jobs, then the number of jobs he would have taken is 12. We could also look at it as 5 being the difference between the number of jobs he got and the number of jobs he took. We could write this formula down as something like the following:

$$17 - 5 = 12$$

OR

$$17 - 2 = 5$$

We'll use the first way it is written down as our example, and then what we'll do is change that into another format that will be easier to work with.

$$\begin{array}{r} 17 \\ -5 \\ \hline ? \end{array}$$

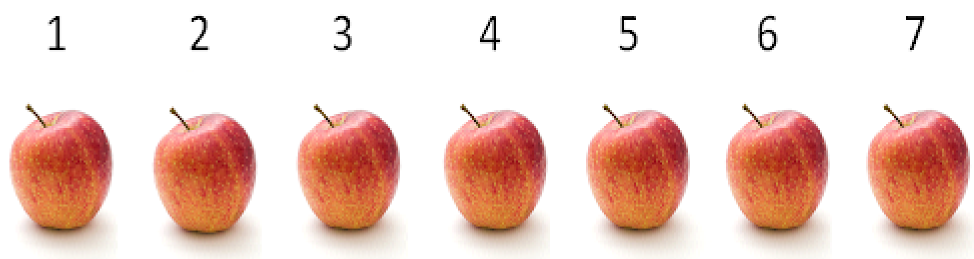
What you might note is that the way the question is written is similar to how we worked the equation when we were adding whole numbers. Writing it this way gives us a better representation of the ones and the tens columns, which we'll need to use when working through the question.

tens ones

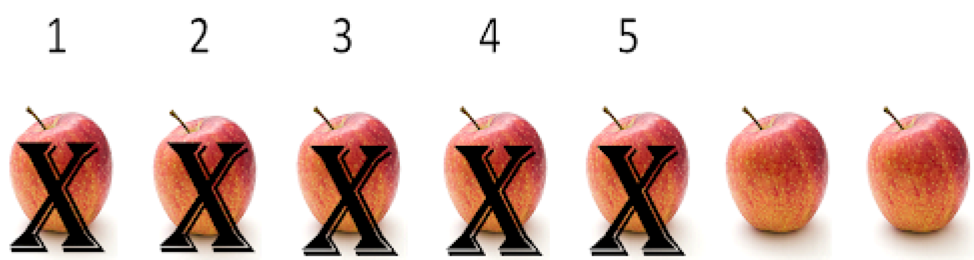
$$\begin{array}{r} 17 \\ -\ 5 \\ \hline \end{array}$$

Subtracting, like adding, requires us to work through each of the columns one by one until we reach our final answer. We'll answer this question visually in order to get the picture.

Start with 7 apples in the ones column.



Remove (or subtract) 5 of those apples, and you are left with 2 apples.



That takes care of the ones columns. We started with 7 apples, then we subtracted 5 apples, leaving us with 2 apples in the ones column. We would say that 2 is the difference between 7 and 5.

ones

$$\begin{array}{r} 17 \\ -\ 5 \\ \hline 2 \end{array}$$

Now off to the tens column.

tens

$$\begin{array}{r} 17 \\ -\,5 \\ \hline 2 \end{array}$$

What is interesting to note here is that there is only one number in the tens column, and that happens to be the number 1. This makes things easy, as there is no work for us to do. We just move the 1 down into the tens column of the answer, and we then have our final answer.

$$\begin{array}{r} 17 \\ -\,5 \\ \hline 12 \end{array}$$

Okay, that was pretty straightforward. Now we'll try something a little more challenging.

Example

Imagine things worked out differently for Harpreet and Jamieson. Let's say that, of those 17 jobs they bid on and successfully got, they had to turn down 9 of them. How many of those jobs would they have taken? Before you continue reading and see the answer, try and visualize what it would look like when we put those numbers into the formula. Do you see the problem?

If we were to start with the ones column as we did in the last example, the problem would show up right away. The problem is that, if you try to subtract 9 from 7, you would end up below zero. So we have to come up with some method of subtracting that compensates for that.

$$7 - 9 = \text{less than zero}$$

$$\begin{array}{r} 17 \\ -\ 9 \\ \hline ? \end{array}$$

What we end up doing is borrowing from the tens column. We would end up with something that looked like this:

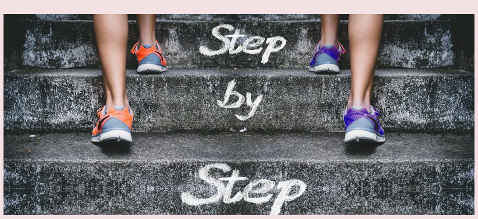
$$\begin{array}{r} 1 \\ 07 \\ -\ 9 \\ \hline 8 \end{array}$$

When we borrow from the tens column, we are borrowing a value of ten and adding it to the ones column to help the ones. We end up with 17 in the ones column, which is now more than enough to deal with the 9 being subtracted. Also, whatever value we had in the tens column (in this case, it was a 1) is reduced by 1 to account for the fact that it has been borrowed.

Example

We'll go through another example in which we return to our plumbers, Harpreet and Jamieson. The three employees they hired are Dixon, Kavanir, and Arman, and it's a good thing they hired them. Those 17 jobs they originally bid on involved the installation of 246 fixtures, including bathtubs, toilets, and sinks. Harpreet and Jamieson could not do all that work by themselves.

But, due to the fact that they turned down 5 jobs, they won't need to install 75 of those fixtures, so with the help of the three new employees, they should be able to complete all the jobs. The question is, "How many fixtures will they have to install?"



As usual, start with the mathematical formula that allows us to properly answer the question. But this time, we'll go through the process using steps, so that when you look back, you can see how it breaks down.

You may have noticed in the first couple of sections that we often go through examples using steps. This is done to break down a large question into manageable parts. If you follow this idea when working through math problems, it can help keep you on track.

Okay, back to the problem:

Step 1: Put the question into a format that is easy to work with.

$$\begin{array}{r} 246 \\ -\ \ 75 \\ \hline \end{array}$$

Step 2: Subtract the ones. In this case, we have 6 minus 5, which equals 1.

$$\begin{array}{r} 246 \\ -\ 75 \\ \hline 1 \end{array}$$

Step 3: Subtract the tens. Here, we have the issue wherein the number on top (4) is less than the number on the bottom (7), so we have to borrow from the hundreds. The 2 in the hundreds column has to be reduced by 1, and then that 1 is added to the tens. We end up with 14 minus 7, which equals 7.

$$\begin{array}{r} {}^{1}\cancel{2}{}^{1}46 \\ -\ 75 \\ \hline 71 \end{array}$$

Step 4: Subtract the hundreds. In this case, we only have the 1, so 1 minus 0 is 1.

$$\begin{array}{r} {}^{1}\cancel{2}{}^{1}46 \\ -\ 75 \\ \hline 171 \end{array}$$

PRACTICE QUESTIONS

Try a couple example questions yourself and check the video answers to see how you did.

Question 1

$$\begin{array}{r} 94 \\ -\ 62 \\ \hline \end{array}$$

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://pressbooks.nscc.ca/foodmath/?p=129

Question 2

$$\begin{array}{r} 434 \\ -\ 78 \\ \hline \end{array}$$

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1.B ADDING WHOLE NUMBERS

CHAD FLINN AND MARK OVERGAARD

Harpreet and Jamieson are currently working a job that requires seven toilets to be installed in one area of the building and six toilets in another. In total, they need to install 13 toilets.

Now, that might not be too hard to do in our heads, but what if we need to add larger numbers? For instance, a job that they are bidding on has 53 toilets and 34 kitchen sinks. That might be harder to add in your head.

An easy way to add is to use a calculator, and if we did, we would get an answer of 87. But learning to add these two whole numbers using math principles can help us not only add the numbers, but also visualize how these numbers go together.

Let's go back to the place value system to help us out:

First, look at 53, which has 5 tens and 3 ones.

Then, look at 34, which has 3 tens and 4 ones.

Add the tens up: 5 tens + 3 tens = 8 tens.

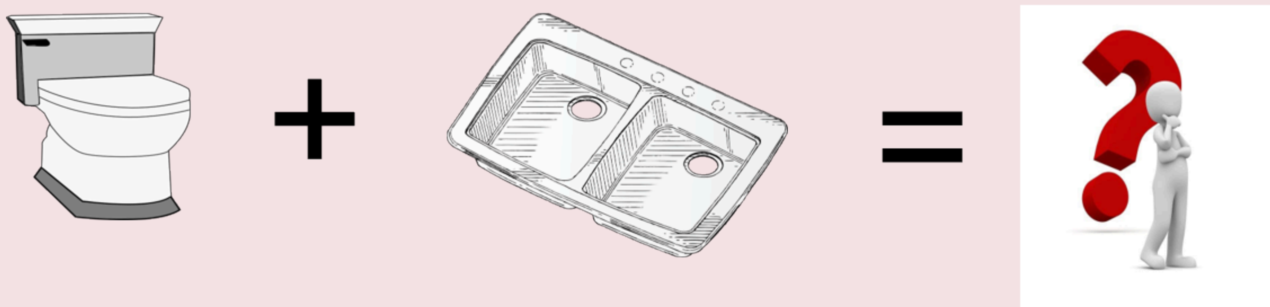
Add the ones up: 3 ones + 4 ones = 7 ones.

When we put the original numbers in the place value system and add, we get a total of 87. Separating this number into each of its digits and positioning them in the place value system can help us visualize the value of each of the digits.

Follow the steps outlined below to see how this process looks mathematically.

Example

We'll use the same numbers from the previous example:



53 34

Step 1: Put the question into a formula that is easy to work with.

$$\begin{array}{r} 53 \\ +\ 34 \\ \hline \end{array}$$

Step 2: Add up the ones. In this case, we have 3 and 4. Together, they add up to 7.

$$\begin{array}{r} 53 \\ +\ 34 \\ \hline 7 \end{array}$$

Step 3: Add up the tens. In this case, we have 5 and 3. Together, they add up to 8.

$$\begin{array}{r} 53 \\ +\ 34 \\ \hline 87 \end{array}$$

That example worked out well, as neither the ones nor the tens added up to more than 9. But what if they did? Take a look at the next example to see how this works.

The word "sum" is math language for adding numbers together. When we say, "What is the sum of 27 and 45?" what we are saying is, "What is the total of those numbers if we added them together?"

Example

Find the sum of 27 and 45.

To get the sum of these numbers, we will go back to our three steps.

Step 1: Put the question into a formula that is easy to work with.

$$\begin{array}{r} 27 \\ +\ 45 \\ \hline \end{array}$$

Step 2: Add up the ones. In this case, we have 7 and 5. Together, they add up to 12. This is where we do what is called "carrying the one." Take a look at the following image to see this in action:

carrying the one

$$\begin{array}{r} {}^{1}27 \\ +\ 45 \\ \hline 2 \end{array}$$

Note: In this case, we do not put the number 12 at the bottom of the equation. Instead, we "carry the one" into the next spot (the tens) in the place value system.

Step 3: Add up the tens. In this case, we have 2 and 4. Together, they add up to 6. We also have to take into account the one that we carried over. We add that in as well to get a total of 7 in the tens place.

$$\begin{array}{r} {}^{1}27 \\ +\ 45 \\ \hline 72 \end{array}$$

Note: If it turned out that the tens added up to more than 9, we could carry the one again into the hundreds column. Take a look below to see how this works.

$$\begin{array}{r} 72 \\ +\ 85 \\ \hline 157 \end{array}$$

As there are no other values in the hundreds column in this question, we just go ahead and place the one in the hundreds column.

PRACTICE QUESTIONS

Try a couple practice questions yourself and check the video answers to see how you did. Make sure to follow the steps outlined above and think about the place value of each of the digits.

Question 1

$$\begin{array}{r} 97 \\ +\ 74 \\ \hline \end{array}$$

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Question 2

$$\begin{array}{r} 128 \\ +\ 456 \\ \hline \end{array}$$

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1.A THE PLACE VALUE SYSTEM

CHAD FLINN AND MARK OVERGAARD

Have you ever heard the term "whole number"? It might seem like a weird concept: aren't all numbers whole? I ate six apples this week, or I charged my electric vehicle for three hours yesterday. Those are whole numbers, right?

Well, not all numbers are whole. You could have eaten 3½ apples during a particularly slow apple-eating week, and maybe you didn't drive your electric vehicle all that much yesterday, so you only had to charge it for 2.3 hours. Those are not whole numbers.

The purpose of this chapter is to define what a whole number is and then learn to work with those whole numbers, be it by adding, subtracting, multiplying, or dividing.

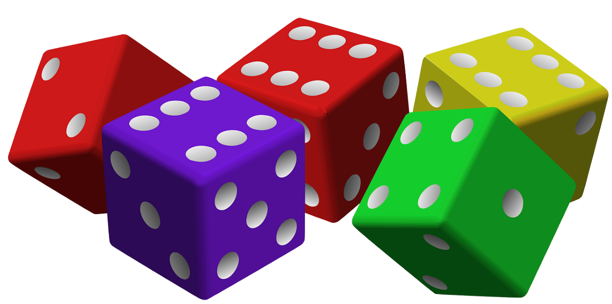
All the chapters in this textbook, including this one, will have examples and exercises geared towards the trades. It contains content relevant to all trades, no matter what trade you are in.

COUNTING NUMBERS AND WHOLE NUMBERS

A number of years ago, a student named Harpreet went through a plumbing apprenticeship program. After completing his schooling and receiving his Red Seal plumbing ticket, he has decided to open up his own plumbing company.

Like most new entrepreneurs, he experienced a steep learning curve, especially when it came to ordering material for jobs and organizing and scheduling when he had a number of jobs on the go.

Although he might not be thinking about counting numbers or whole numbers, he has ended up working with these when ordering materials and during the day-to-day operations of the company.



If we want to start with the very basics, we must start with **counting numbers**, which are sometimes referred to as **natural numbers**. These are the most basic units in algebra and the ones we use to count objects. For instance, Harpreet had to order one toilet, two sets of taps, three fittings, four braided hoses, and five chocolate bars (it seems like Harpreet has a bit of a sweet tooth).

One more thing: in counting numbers, there are no decimal or fraction parts. Also, there are no negatives and no zero.

Okay, so we have no zero. But what if we just decided to add a zero to the set of counting numbers? Would that be so bad? No, it wouldn't, but then we couldn't call them counting numbers anymore. The set of counting numbers plus zero becomes what is known as the set of **whole numbers**.

Counting numbers: 1, 2, 3, 4, 5, …

Whole numbers: 0, 1, 2, 3, 4, 5, …

The discovery of the number zero was a big step in the history of mathematics. Don't ask me why, but apparently it was. As for Harpreet, let's hope that he bids jobs properly and that his profit doesn't amount to zero.

THE PLACE VALUE SYSTEM

Worried that he might estimate jobs improperly, Harpreet decides he needs some help with estimating and bidding jobs, as well as some help with the books. He calls up his friend Jamieson and asks if he wants to help. Jamieson, who has been in the plumbing industry for a number of years, has had a recurring back injury and figures this might be a good opportunity to rest his back for a while and help his friend out at the same time.

The first job Jamieson bids on is for $931. Take a look at the three numbers in 931 and notice where each one is located. This is very important, because if Jamieson reversed the numbers, he would have bid $139 and most likely lost money on the job.

Writing the correct number relies on what our number system calls the **place value system**. The 9, the 3, and the 1 are all located in different spots in the larger number, and each of them is called a **digit**. Putting the digits in the wrong locations could result in disaster when dealing with money and in many other situations.

Here's a visual example: say I were to take a wallet, open it up, and take out the money. Suppose that wallet had two $100 bills, three $20 bills and one $5 bill. What would the total amount of money be in the wallet?

I would have:

$$2 \times \$100 = \$200$$

$$3 \times \$20 = \$60$$

$$1 \times \$5 = \$5$$

Adding those up, I would have:

$$\$200 + \$60 + \$5 = \$265$$

Notice that each of the original values has a specific place in the total. Positioning the digits in the reverse order would make it appear as if we had a lot more money than we actually have:

$$\$562$$

This is the importance of the place value system.

Another aspect of this system is known as the **base-10 concept**. Each position in a number is a specific place. If we use the number 265 as an example, we would see that:

5 = ones place

6 = tens place

2 = hundreds place

Each of the digits in the place value system can have a value anywhere between zero and nine. When the value of a digit increases past nine, we start again at zero but add one to the value of the digit in the next highest place value.

The simplest way to think about this is to go from 9 to 10:

$$\mathbf{9} \longrightarrow \mathbf{10}$$

In this case, the ones place goes back to zero and the tens place increases by one.

The ones place has gone from nine to zero.

$$\mathbf{9} \longrightarrow \mathbf{10}$$

There was no value in the tens place when we started, but now, the tens place has increased by one.

Now, you might be thinking that this really is far too basic to be reading, but these are the building blocks of the language of algebra. Although the example used here is quite simple, when you get to larger and more complex numbers, the mathematical grammar that you are learning here is the basis for understanding more complicated mathematical grammar in the chapters to follow.

Now let's look at a bigger number. One way to understand the place value system is to take a number such as:

$$5,217,364,958$$

If we were to sound out this number, we would say:

Five billion, two hundred and seventeen million, three hundred and sixty-four thousand, nine hundred and fifty-eight.

It's read that way because each digit corresponds to a certain value in the place value system. Take a look at the following place value chart, in which we start with the ones and work our way up:

Ones	8
Tens	5
Hundreds	9
Thousands	4
Ten thousands	6
Hundred thousands	3
Millions	7
Ten millions	1
Hundred millions	2
Billions	5
Ten billions	–
Hundred billions	–

This pattern would continue on into the trillions, quadrillions, quintillions, and so on.

Another common way to express numbers in the place value system is demonstrated in the table below.

Place Value														
Trillions			Billions			Millions			Thousands			Ones		
Hundred Trillions	Ten Trillions	Trillions	Hundred Billions	Ten Billions	Billions	Hundred Millions	Ten Millions	Millions	Hundred Thousands	Ten Thousands	Thousands	Hundreds	Tens	Ones
					5	2	1	7	3	6	4	9	5	8

Place value table with values added.

Going from left to right, we get:

- The digit 5 is in the billions place. Its value is 5,000,000,000.
- The digit 2 is in the hundred millions place. Its value is 200,000,000.
- The digit 1 is in the ten millions place. Its value is 10,000,000.
- The digit 7 is in the millions place. Its value is 7,000,000.
- The digit 3 is in the hundred thousands place. Its value is 300,000.
- The digit 6 is in the ten thousands place. Its value is 60,000.
- The digit 4 is in the thousands place. Its value is 4,000.
- The digit 9 is in the hundreds place. Its value is 900.
- The digit 5 is in the tens place. Its value is 50.
- The digit 8 is in the ones place. Its value is 8.

Try an example.

Example

As you go through this question, think of the actual value of each of the digits. For example, the 4 in the leftmost place of the number below represents 40,000,000. Doing this will help you to visualize the value each number actually stands for.

Find the place value of each of the following digits:

$$45,837,249$$

Use the following layout as a guideline to help you answer the question.

4 = ____________________

5 = _____________________

8 =_____________________

3 =_____________________

7 =_____________________

2 = _____________________

4 = _____________________

9 = _____________________

Inserting the numbers into the table below is also a good place to start:

Place Value														
Trillions			Billions			Millions			Thousands			Ones		
Hundred Trillions	Ten Trillions	Trillions	Hundred Billions	Ten Billions	Billions	Hundred Millions	Ten Millions	Millions	Hundred Thousands	Ten Thousands	Thousands	Hundreds	Tens	Ones
							4	5	8	3	7	2	4	9

Solution:

Using the table above, you get:

4 = ten millions
5 = millions
8 = hundred thousands
3 = ten thousands
7 = thousands
2 = hundreds
4 = tens
9 = ones

PRACTICE QUESTIONS

Try a couple more examples and check out the video answers.

Find the place value of each digit of the following numbers.

Question 1

$$385,922,102$$

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://pressbooks.nscc.ca/foodmath/?p=93

Question 2

$$20,433,876,011$$

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UNIT 2 - IMPERIAL & U.S SYSTEMS

2.1 IMPERIAL AND U.S. SYSTEMS OF MEASUREMENT

Canada used the U.S. and imperial systems of measurement until 1971 when the S.I. or metric system was declared the official measuring system for Canada, which is now in use in most of the world, with the United States being the major exception. However, "declaring" and "truly adopting" are not always the same.

Because of Canada's strong ties to the United States, a lot of our food products come from across the border, and many Canadian producers also sell in the U.S. market. This is one of the main reasons Canadians need to know how to work in both systems. Most Canadian packages include both Canadian and U.S. or imperial measurements on the label, and many suppliers still quote prices in cost per pound instead of cost per kilogram.

The most commonly used units of measurement in the U.S. and imperial systems are shown in Table 6.

Table 6: U.S. and imperial units of measurement

Type of Measurement	Unit	Abbreviation
Weight	Pound	lb. or #
Weight	Ounce	oz.
Volume	Gallon	gal.
Volume	Quart	qt.
Volume	Pint	pt.
Volume	Cup	c.
Volume	Fluid ounce	fl.oz. or oz.
Volume	Tablespoon	Tbsp. or tbsp.
Volume	Teaspoon	tsp.
Length	Mile	m.
Length	Yard	yd.
Length	Foot	ft. or ′
Length	Inch	in. or ″

Note: There is sometimes confusion about the symbol #. When # is used in front of a number, such as in #10, the # is read as the word *number*. Thus, #10 is read as *number 10*. When the # follows a number, the # is read as *pounds*. Thus, 10# is read as *10 pounds*.

DIFFERENCES BETWEEN THE U.S. AND IMPERIAL SYSTEMS

The only difference between the imperial system and the U.S. system is in volume measurements. Not only are the number of ounces in pints, quarts, and gallons all larger in the imperial system, the size of one fluid ounce is also different, as shown in the table in Table 7.

Table 7: Differences between U.S. and imperial volume measurements

Unit of Measurement	Imperial System	Metric Equivalent	U.S. System	Metric Equivalent
1 ounce	1 (fluid) oz.	28.41 mL	1 (fluid) oz.	29.57 mL
1 gill	5 (fluid) oz.	142.07 mL	Not commonly used	
1 cup	Not commonly used		8 (fluid) oz.	236.59 mL
1 pint	20 (fluid) oz.	568.26 mL	16 (fluid) oz.	473.18 mL
1 quart	40 (fluid) oz.	1.137 L	32 (fluid) oz.	946.36 mL
1 gallon	160 (fluid) oz.	4.546 L	128 (fluid) oz.	3.785 L

Where you will notice this most is with any liquid products manufactured in Canada; these products will show the metric conversion using imperial measurement, but any products originating in the United States will show the conversion using U.S. measurements. For example, if you compare 12 fl. oz. bottles or cans of soft drinks or beer, you will see that American brands contain 355 mL (12 fl. oz. U.S.) and Canadian brands contain 341 mL (12 fl. oz. imperial).

If you are using a recipe written in cups and ounces, always verify the source of your recipe to determine if it has been written using the U.S. or imperial system of measurement. The difference in volume measurements can be quite noticeable when producing large quantities.

If the recipe is from the United States, use U.S. measurements for the conversion, if the recipe originated in the United Kingdom, Australia, or any other country that was once part of the British Empire, use imperial for the conversion.

CONVERTING BETWEEN UNITS IN THE IMPERIAL AND U.S. SYSTEMS

On occasion, you may need to convert between the various units of volume and between units of volume and units of weight in the U.S. system. To do this, you must know the equivalents for each of the units as shown in Table 8.

Table 8: Equivalent measures within the U.S. and Imperial system

Types of Measurement	Conversion
Weight	1 pound = 16 ounces
Volume (U.S.)	1 gallon = 4 quarts or 128 (fluid) ounces
Volume (U.S.)	1 quart = 2 pints or 4 cups or 32 (fluid) ounces
Volume (U.S.)	1 pint = 2 cups or 16 (fluid) ounces
Volume (U.S.)	1 cup= 8 (fluid) ounces or 16 tablespoons
Volume (U.S.)	1 (fluid) ounce = 2 tablespoons
Volume (U.S.)	1 tablespoon = 3 teaspoons
Volume (imperial)	1 gallon = 4 quarts or 160 (fluid) ounces
Volume (imperial)	1 quart = 2 pints or 40 (fluid) ounces
Volume (imperial)	1 pint = 20 (fluid) ounces
Volume (imperial)	1 gill = 5 (fluid) ounces or 10 tablespoons
Volume (imperial)	1 (fluid) ounce = 2 tablespoons
Volume (imperial)	1 tablespoon = 3 teaspoons
Length	1 mile = 1760 yards
Length	1 yard = 3 feet
Length	1 foot = 12 inches

Note: One fluid ounce (usually called, simply, *ounce*) of water weighs approximately one ounce.

To convert from one unit to another, you either divide or multiply, depending on whether you are converting a smaller unit to a larger one, or a larger unit or to a smaller one.

CONVERTING SMALLER TO LARGER UNITS

To convert from a smaller to a larger unit, you need to divide. For example, to convert 6 tsp. to tablespoons, divide the 6 by the number of teaspoons in one tablespoon, which is 3 (see Table 8).

6 tsp = __ tbsp.

6 ÷ 3 = 2

6 tsp. = 2 tbsp.

To convert ounces to cups, you need to divide by 8 since there are 8 oz. in 1 cup. For example, if you need to convert 24 oz. to cups, you have to divide 24 by 8.

24 oz. = __ cups

24 ÷ 8 = 3

24 oz. = 3 cups

CONVERTING LARGER TO SMALLER UNITS

To change larger units to smaller, you have to multiply the larger unit by the number of smaller units in that unit. For example, to convert quarts to pints, you have to multiply the number of quarts by 2 because there are 2 pts. in 1 qt. Therefore, to convert 6 qts. to pints you need to multiply:

6 qts. = __ pts.

6 × 2 = 12

6 qts. = 12 pts.

To convert cups to tablespoons, you need to multiply by 16 since there are 16 tbsp. in 1 cup.

3/4 cup = __ tbsp.

16 × 3/4 = 12

3/4 cup = 12 tbsp.

CONVERTING BETWEEN METRIC AND IMPERIAL/U.S. MEASUREMENT SYSTEMS

You can convert between metric and imperial or U.S. measurements with straightforward multiplication or division if you know the conversion **ratios.** Table 9.1 and 9.2 are a good reference, but there are also many online converters or apps available to make this task easier.

Table 9.1: Convert from metric to imperial/U.S.

When you know	Divide by	To get
millilitres	4.93	teaspoons
millilitres	14.79	tablespoons
millilitres	28.41	fluid ounces (imperial)
millilitres	29.57	fluid ounces (U.S.)
millilitres	236.59	cups
litres	0.236	cups
millilitres	473.18	pints (U.S.)
litres	0.473	pints (U.S.)
millilitres	568.26	pints (imperial)
litres	0.568	pints (imperial)
millilitres	946.36	quarts (U.S.)
litres	0.946	quarts (U.S.)
millilitres	1137	quarts (imperial)
litres	1.137	quarts (imperial)
litres	3.785	gallons (U.S.)
litres	4.546	gallons (imperial)
grams	28.35	ounces
grams	454	pounds
kilograms	0.454	pounds
centimetres	2.54	inches
millimetres	25.4	inches
Celsius (Centigrade)	multiply by 1.8 and add 32	Fahrenheit

Table 9.2: Convert from imperial/U.S. to metric

When you know	Multiply by	To get
teaspoons	4.93	millilitres
tablespoons	14.79	millilitres
fluid ounces (imperial)	28.41	millilitres
fluid ounces (U.S.)	29.57	millilitres
cups	236.59	millilitres
cups	0.236	litres
pints (U.S.)	473.18	millilitres
pints (U.S.)	0.473	litres
pints (imperial)	568.26	millilitres
pints (imperial)	0.568	litres
quarts (U.S.)	946.36	millilitres
quarts (U.S.)	0.946	litres
quarts (imperial)	1137	millilitres
quarts (imperial)	1.137	litres
gallons (U.S.)	3.785	litres
gallons (imperial)	4.546	litres
ounces	28.35	grams
pounds	454	grams
pounds	0.454	kilograms
inches	2.54	centimetres
inches	25.4	millimetres
Fahrenheit	subtract 32 and divide by 1.8	Celsius (Centigrade)

Table 10 lists the most common U.S. measurements and metric units of measure, and their equivalents used in professional kitchens. Table 11 presents the conversion factors.

Table 10: Common Metric and U.S. conversions

Measurement type	Unit	Equivalent
Length	1 inch	25.4 millimetres
Length	1 centimetre	0.39 inches
Length	1 metre	39.4 inches
Volume	1 fluid ounce (U.S.)	29.57 millilitres
Volume	1 cup	237 millilitres
Volume	1 quart	946 millilitres
Volume	1 millilitre	0.034 fluid ounces
Volume	1 litre	33.8 fluid ounces
Weight	1 ounce	28.35 grams
Weight	1 pound	454 grams
Weight	1 gram	0.035 ounce
Weight	1 kilogram	2.205 pounds

Table 11: Metric and U.S. Equivalents and Conversions

Measurement type	To convert	Multiply by	Result
Length	Inches to millimeters	25.4	1 inch = 25.4 mm
Length	Inches to centimetres	2.54	1 inch = 2.54 cm
Length	Millimetres to inches	0.03937	1 mm = 0.03937 in.
Length	Centimetres to inches	0.3937	1 cm = 0.3937 in.
Length	Metres to inches	39.3701	1m = 39.37 in.
Volume	Quarts to litres	0.946	1 qt. = 0.946 L
Volume	Litres to fluid ounces (U.S.)	33.8	1 L = 33.8 oz.
Volume	Quarts to millilitres	946	1 qt. = 946 mL
Volume	Millilitres to ounces	0.0338	1 mL = 0.0338 oz.
Volume	Litres to quarts	1.05625	1 L = 1.05625 qt.
Weight	Ounces to grams	28.35	1 oz. = 28.35 g
Weight	Grams to ounces	0.03527	1 g = 0.03527 oz.
Weight	Kilograms to pounds	2.2046	1 kg = 2.2046 lb.

SOFT CONVERSIONS

Many times, cooks will use what are called “soft conversions” rather than exact conversions, especially in small batch recipes where a slight variation can be tolerated, as it is often difficult to measure very fine quantities using liquid measures. This is a shortcut that can be used if you are faced with only a set of metric measuring tools and a U.S. recipe (or vice versa). Table 12 lists the common soft conversions.

Table 12: Soft conversions

Metric	U.S. Measurements
1 millilitre	1/4 teaspoon
2 millilitres	1/2 teaspoon
5 millilitres	1 teaspoon
15 millilitres	1 tablespoon
30 millilitres	1 fluid ounce
250 millilitres	1 cup
500 millilitres	1 pint
1 litre	1 quart
4 litres	1 gallon

TYPES OF MEASUREMENTS USED IN THE KITCHEN

There are three types of measurements used to measure ingredients and to serve portions in the restaurant trade. Measurement can be by volume, by weight, or by **count.**

Recipes may have all three types of measurement. A recipe may call for 3 eggs (measurement by count), 250 mL of milk (measurement by volume), and 0.5 kg of cheese (measurement by weight).

There are formal and informal rules governing which type of measurement should be used. There are also specific procedures to ensure that the measuring is done accurately and consistently.

NUMBER OR COUNT

Number measurement is only used when an accurate measurement is not critical and the items to be used are understood to be close in size.

For example, "3 eggs" is a common measurement called for in recipes, not just because 3 is easy to count but also because eggs are graded to specific sizes. Most recipes call for large eggs unless stated otherwise.

Numbers are also used if the final product is countable. For example, 24 premade tart shells would be called for if the final product is to be 24 filled tart shells.

VOLUME

Volume measurement is usually used with liquids or fluids because such items are awkward to weigh. It is also used for dry ingredients in home cooking, but it is less often used for dry measurement in the industry.

Volume is often the measure used when portioning sizes of finished product. For example, portion scoops are used to dole out vegetables, potato salad, and sandwich fillings to keep serving size consistent. Ladles of an exact size are used to portion out soups and sauces.

Often scoops and ladles used for portioning are sized by number. On a scoop, such a number refers to the number of full scoops needed to fill a volume of one litre or one quart. Ladles are sized in millilitres or ounces.

WEIGHT

Weight is the most accurate way to measure ingredients or portions. When proportions of ingredients are critical, their measurements are always given in weights. This is particularly true in baking where it is common to list all ingredients by weight, including eggs (which, as mentioned earlier, in almost all other applications are called for by count). Whether measuring solids or liquids, measuring by weight is more reliable and consistent.

Weighing is a bit more time consuming and requires the use of scales, but it pays off in accuracy. Digital portion scales are most commonly used in industry and come in various sizes to measure weights up to 5 kg (11 lbs.). This is adequate for most recipes, although larger operations may require scales with a larger capacity.

The reason weight is more accurate than volume is because it takes into account factors such as density, moisture, and temperature that can have an effect on the volume of ingredients. For example, 250 mL (1 cup) of brown sugar (measured by volume) could change drastically depending on whether it is loosely or tightly packed in the vessel. On the other hand, 500 grams (17.63 oz.) of brown sugar, will always be 500 grams (17.63 oz.).

Even flour, which one might think is very consistent, will vary from location to location, and the result will mean an adjustment in the amount of liquid needed to get the same consistency when mixed with a given volume.

Another common mistake is interchanging between volume and weight. The only ingredient that will have the same volume and weight consistently is water: 1 L of water = 1 kg of water.

There is no other ingredient that can be measured interchangeably because of gravity and the density of an item. Every ingredient has a different density and different gravitational weight, which will also change according to location. This is called **specific gravity.** Water has a specific gravity of 1.0. Liquids that are lighter than water (such as oils that float on water) have a specific gravity of less than 1.0. Those that are heavier than water and will sink, such as molasses, have a specific gravity greater than 1.0. Unless you are measuring water, remember not to use a volume measure for a weight measure, and vice versa.

Example 4

1 L water = 1 kg water

1 L water + 1 L canola oil = 2 L of water and oil mixture (volume)

1 L water + 1 L canola oil = 1.92 kg (weight)

In order to convert your existing recipes that only call for volume measurement to weight, you will need to measure each ingredient by volume, weigh it, and then record the amount in your recipe. There are also tools that can help with this conversion.

- Aqua-calc: Online Food Calculator is an online calculator has an extensive database of foods and can convert from volume to weight in both the metric and U.S. measuring systems.
- Lee Valley Kitchen Calculator is a conversion calculator has the capacity to convert between weight and volume. It comes with an attached list of ingredients and their specific gravitational weights. It is, however, a list of only the most common ingredients and will not likely cover everything that a commercial kitchen uses.

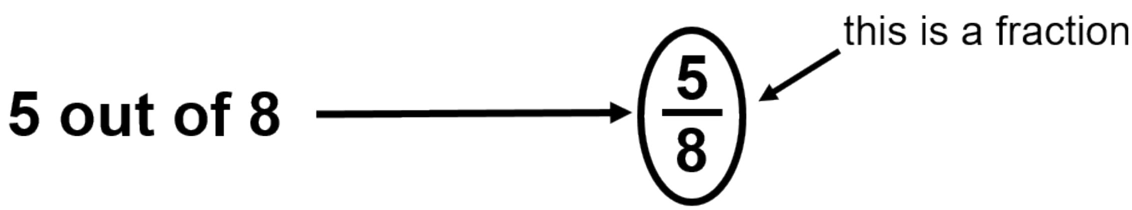
MATH FOUNDATION FOR UNIT 2: FRACTIONS

2.A THE BASICS OF FRACTIONS

CHAD FLINN AND MARK OVERGAARD

What exactly is a fraction, anyway? Have you ever dealt with fractions in either your schooling or your work? Well, a fraction is a part (or portion) of a whole.

Say you ordered a pizza and there were a total of 8 slices. You were hungry that day and you had 5 of them, therefore eating 5 out of the 8 slices. That can be represented as a fraction.



DEFINING A FRACTION

Our story of fractions begins with Abigail, Hanna, and Naomi, who are electrical apprentices going through their schooling at the same time who hope to open a company together once they get their Red Seal Electrical Tickets.

We'll start with a couple of definitions. Every fraction has two parts: the numerator and the denominator. Let's take a look at a fraction to define each.

$$\frac{1}{3}$$

Numerator: The number above the line in a fraction. It indicates how many parts of the whole are being counted.

Denominator: The number below the line in a fraction. It indicates how many total parts are in the whole.

If Abigail, Hanna, and Naomi did end up owning a company, each would own ⅓ of that company. Each person represents 1 owner, and together, there are 3 owners in the whole company.

Here are a few more examples of fractions:

$$\frac{1}{2} \quad \frac{3}{8} \quad \frac{5}{16} \quad \frac{4}{9} \quad \frac{7}{15} \quad \frac{77}{145}$$

MIXED NUMBERS AND IMPROPER FRACTIONS

The examples above are all of typical fractions, but we don't always see fractions in that form. There are two other styles of fractions that we deal with: **mixed numbers** and **improper fractions**.

MIXED NUMBERS

Let's say the three apprentices get together one night to talk about the future, and they order 2 pizzas, each with 8 pieces.

Ham and Pineapple

Vegetarian

(I know the pizzas look exactly the same, but you'll have to trust me on this one. One thing for sure is that each pizza has 8 slices, and someone has gone ahead and had a taste test of both pizzas.)

We need to break this down: we have a total of 2 pizzas, each with 8 slices. That makes for a total of 16 slices. If the apprentices eat 1 whole pizza, they will have eaten 8 out of 8 slices.

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

Now let's say that one of the three of them has another slice from the second pizza. They will have now eaten 1 whole pizza plus 1 slice.

$$1 + \frac{1}{8} = 1\frac{1}{8} \longleftarrow \text{Mixed number}$$

This is what is known as a mixed number. A mixed number can be defined as the following:

Mixed number: A combination of a whole number and a fraction.

Next, we cover improper fractions.

IMPROPER FRACTIONS

Improper fraction: A fraction in which the numerator is larger than the denominator.

What this means is that the number on the top of the fraction is larger than the number on the bottom.

We'll stick to our pizza example. Together, the apprentices have eaten a total of 9 slices. This accounts for 1 whole pizza plus 1 slice from the second pizza. Written as an improper fraction, the number of pizzas eaten would look like this:

$$\frac{9}{8}$$

Now, we want to change a mixed number into an improper fraction, and then do the reverse and take an improper fraction and change it back to a mixed number.

Example

Change the following mixed number into an improper fraction:

$$1\frac{3}{4}$$

Step 1: Change the whole number into a fraction, with the denominator being 4.

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

Step 2: Add the two fractions together. Now, we'll have to jump ahead a little here, as we haven't covered adding fractions yet. I'll give you the cheap and easy version here. As long as the denominators are the same, we are all good. When adding fractions, we simply keep the denominators the same and add the numerators. (We'll go through adding fractions thoroughly in the next chapter.)

$$\frac{4}{4} + \frac{3}{4} = \frac{7}{4}$$

So:

$$1\frac{3}{4} = \frac{7}{4}$$

Another way to find your answer would be as follows:

$$1\frac{3}{4} = 1\,\frac{+\;3}{\times\;4} = \frac{7}{4}$$

That may look a little confusing, but follow me through it. With the mixed number 1 ¾, take the 4 and multiply it by the 1. Then add 3, and you end up with 7. It's the same answer — just a different way of getting there.

Try going from a mixed number to an improper fraction by yourself.

Practice Question A

Change the following into an improper fraction. Check the video answer to see how you did.

$$3\frac{3}{8}$$

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All right: hopefully, you've got the mixed-number-to-improper-fraction calculation down. But what about the reverse? We should go through an example of that as well, and then give you a chance to work through one yourself.

Example

Change the following improper fraction into a mixed number:

$$\frac{27}{6}$$

Step 1: Find out how many times 6 goes into 27. We can do this using long division. The good news here is that we already went through long division in the first chapter. If you need to review it, take a look back to see how it's done (see Dividing Whole Numbers).

$$\begin{array}{r} 4 \\ 6\overline{)27} \\ \underline{24} \\ 3 \end{array}$$

What we end up with is 6 going into 27 four times with 3 left over. So our mixed number becomes:

$$4\frac{3}{6}$$

Try another practice question.

Practice Question B

Change the following improper fraction into a mixed number. Check out the video answer to see how you did.

$$\frac{17}{3}$$

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REDUCING FRACTIONS

Before we move on to adding and subtracting fractions, we should touch on another concept known as reducing fractions. Reducing is what we do when we want to make a smaller version of a fraction that still has the same mathematical value as the original.

Back to our pizza. Once again, we have 8 slices per pizza. Now, say we eat 4 of those slices. We have eaten:

$$\frac{4}{8}\ \begin{array}{l}\text{number of slices eaten}\\ \text{number of slices in pizza}\end{array}$$

If someone asked you how much pizza you had, how would you answer? Would you say, "I had 4 out of a possible 8 slices," or would you say, "I ate half the pizza"? I think we'd all agree that we would just say that we ate half the pizza, as 4 pieces would amount to half the pizza. If we were to write half as a fraction, it would look like this:

$$\frac{1}{2}$$

We could then conclude that the two fractions represent the same thing mathematically, and they are just two different ways to represent the same thing. You could look at it this way: I cut two pieces of wood. One is 12 inches in length, and the other is 1 foot in length. They are the same length — their lengths are just expressed in different ways. So in the end, we end up with this:

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

What we've done is reduced the fraction from 4 over 8 to 1 over 2 without changing the actual value represented. How this was done mathematically is we took the original numerator of 4 and divided it by 4. What is done to one part of the fraction must also be done to the other, so we also divided the denominator of 8 by 4, resulting in a fraction of 1 over 2.

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

Doing the same thing to both the numerator and the denominator guarantees that the original fraction and the final fraction are equal in value.

We reduce fractions when we can evenly divide the same number into both the numerator and the denominator. In our example, 4 can be divided into both. Note that the number 2 can also be divided into both the numerator and the denominator. If we divided both by 2, we would get:

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

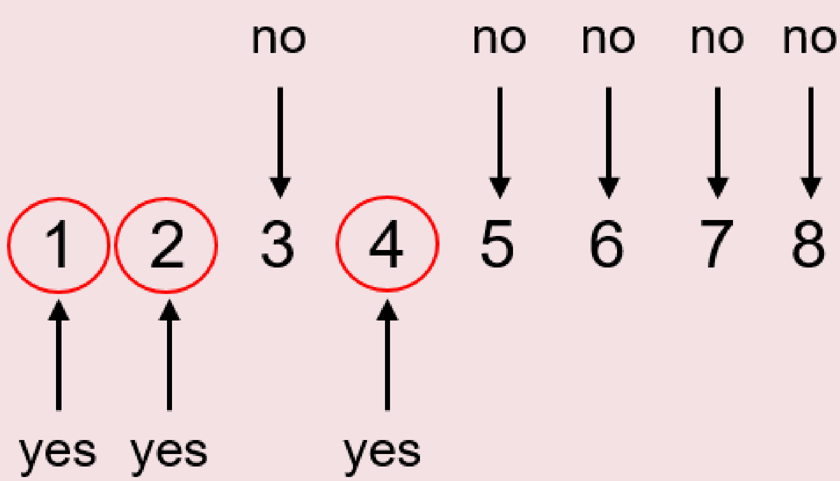
Although this still works mathematically, we often want to get a fraction into its lowest terms, meaning to a point where it can no longer be reduced. The fraction 2 over 4 could be reduced even further to 1 over 2, so there is further work we could do, if we chose to.

Example

Let's go through the thought pattern when reducing fractions. Take the following fraction and reduce it to its lowest terms:

$$\frac{8}{12}$$

Step 1: What we want to do here is take a look at both the numerator and the denominator and determine if there is a number that can go into both of them. It might be easier if you write down numbers starting from 1 and then decide which numbers can go into both 8 and 12.



From this, we can conclude that the largest number that can go into both 8 and 12 is 4.

Step 2: Divide both the numerator and the denominator by 4.

$$\frac{8 \div 4}{12 \div 4} = \frac{2}{3}$$

There you have it: the fraction has now been reduced to its lowest terms. Always take a look at the answer when you are done, just to make sure that there definitely isn't another number that can go into the numerator and denominator, as this would mean the fraction could be reduced even further.

The example shown above is fairly straightforward. Once there are larger numbers involved, it is sometimes easier to work through the question in a couple of steps to slowly reduce the fraction. Take a look at the following example to see what I mean.

Example

Reduce the following fraction into its lowest terms:

$$\frac{24}{168}$$

Step 1: Determine if there is a number that can go into both the numerator and the denominator. If there is more than one number, then use the larger number.

This is a bit tougher than the first question, as the numbers are a lot larger and harder to work with. Going back to our times tables, we can see that 6, 8, and 12 all go into 24. We could also say that 24 goes into 24. But what about 168? What goes into that?

One thing we know for sure is that 2 goes into both, so why don't we start by taking each part of the fraction and dividing it by 2. If you have trouble dividing 168 by 2 in your head, go ahead and use your calculator.

$$\frac{24 \div 2}{168 \div 2} = \frac{12}{84}$$

Step 2: Determine if the fraction can be reduced any further. We can see that, once again, we can divide both numbers by 2.

$$\frac{12 \div 2 =}{84 \div 2 =} \quad \frac{6}{42}$$

Step 3: Repeat step 2 and determine if the fraction can be reduced any further. What we note this time is that 6 can go into both 6 and 42, so we divide both the numerator and the denominator by 6.

$$\frac{6 \div 6 =}{42 \div 6 =} \quad \frac{1}{7}$$

There you have it: we have reduced that large fraction into its lowest terms in just a few steps. I will admit that, if we had used a calculator for this whole procedure, we could have come up with the answer with less work, but that is not the point. Doing it the long way starts to train your brain in the relationships between numbers. As you get more familiar with numbers, you will be able to pick apart patterns and understand the relationships formed in math. Although it might be a little more time-consuming in the beginning, the payoff as time goes by is great.

PRACTICE QUESTIONS

Try a couple questions for yourself and check the video answers to see how you did.

Reduce the following fractions into their lowest terms.

Question 1

$$\frac{15}{18}$$

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Question 2

$$\frac{24}{36}$$

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2.B ADDING AND SUBTRACTING FRACTIONS

CHAD FLINN AND MARK OVERGAARD

ADDING FRACTIONS WITH COMMON DENOMINATORS

Abigail, Hanna, and Naomi are studying for their midterm exam. The material they are required to study consists of 16 chapters of reading. The three of them realize that 16 chapters is a lot of reading for each of them to do, so they decide to study in a more efficient manner. They come up with a plan in which each of them reads a certain number of chapters and then summarizes it for the other two. They will share notes, and each will find online videos corresponding to their particular set of chapters.

Now, the chapters are not created equally. Some are quite easy, while others are much tougher. Their goal is to spread the workload evenly between the three of them. Remember that there are 16 chapters.

Abigail has the highest number of chapters to go through with 6. Hanna has 5, while Naomi has only 4. If you were to add those up, you would notice that that only comes to 15 chapters. The last chapter in the book is about troubleshooting electrical systems, and the apprentices decide that they will go through that one together.

We can represent each of their workloads as a fraction of a whole:

$$\text{Abigail has } \frac{6}{16}$$

$$\text{Hanna has } \frac{5}{16}$$

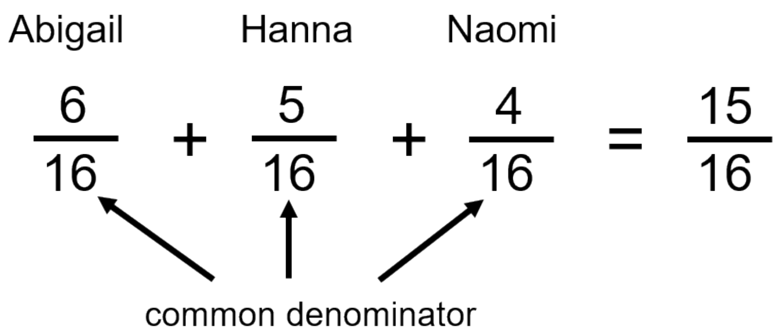
$$\text{Naomi has } \frac{4}{16}$$

What if were to add those fractions? It would look something like this:

$$\frac{6}{16}+\frac{5}{16}+\frac{4}{16}=?$$

What you'll note is that the numerators are all different, while the denominators are all the same (16). When adding or subtracting fractions, the denominators must be the same. We refer to this as having a common denominator.

So, in order to get the answer to the above question, you just add all the numerators. Adding fractions is very simple in this respect.



Notice that the denominator in the final answer is the same as that in the fractions being added. By the end, the apprentices will have gone through 15 of the 16 chapters separately, and then they will go through the last chapter together.

The concept of adding fractions with common denominators is easy enough, and we did enough adding whole numbers that going through examples at this point might not be worth it (but if you need a review, see Adding Whole Numbers). What we will do instead is write down some examples of adding fractions so you can see the idea.

$$\frac{1}{8}+\frac{2}{8}=\frac{3}{8}$$

$$\frac{5}{16}+\frac{6}{16}=\frac{11}{16}$$

$$\frac{13}{32}+\frac{11}{32}=\frac{24}{32}$$

Do you notice anything about the answer to the last one? It can be reduced.

$$\frac{24}{32} \longrightarrow \frac{2}{3}$$

Before we get going any further with work on fractions, this might be a good time to state that, when working with fractions, we generally want to put the answer in lowest terms.

SUBTRACTING FRACTIONS WITH COMMON DENOMINATORS

What about subtracting fractions? Well, it follows the same principle: you must have a common denominator, and then you subtract the numerators. Here are some examples of subtracting fractions:

$$\frac{5}{8} - \frac{2}{8} = \frac{3}{8}$$

$$\frac{9}{16} - \frac{5}{16} = \frac{4}{16} \longrightarrow \frac{1}{4}$$

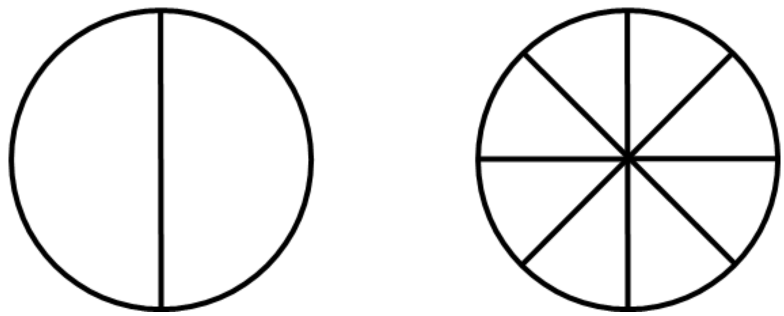
$$\frac{27}{32} - \frac{14}{32} = \frac{13}{32}$$

ADDING AND SUBTRACTING FRACTIONS WITH UNCOMMON DENOMINATORS

We're going to step it up a bit now. Our examples of adding and subtracting fractions are fairly straightforward, due to the fact that the denominators are the same. A more difficult situation involves adding or subtracting fractions that have different denominators. Take a look at the following example:

$$\frac{1}{2} + \frac{3}{8} = ?$$

We can't simply add up the numerators and the denominators, as it just won't work. Take a look at the two circles drawn below. One is split into 2 parts, and one is split into 8 parts. Do you notice anything about the sizes of the parts?



You'll note that the parts in the 2-part circle are much larger than those in the 8-part circle. If we were to add up the parts in each of the circles, it would be like adding apples and oranges.

So the idea becomes making it so that the parts we are adding are the same size. If we can somehow get to that point, then we are good to go, and we can add the two fractions. This is referred to as finding a common denominator, and most often, we try and find the **lowest common denominator**.

Lowest common denominator: The lowest number that two denominators can evenly go into.

Take a look at the equation below. One of the denominators is 2, while the other is 8.

$$\frac{1}{2} + \frac{3}{8} = ?$$

The process here is similar to when we were putting fractions into their lowest terms in the last section, only this time, we will be increasing at least one of the denominators, and sometimes, we will be increasing both until we find one that is common. What we are looking for is a number that both denominators can go into evenly. In this example, we see that 2 can go into 8 and 8 can go into 8. This leaves us with a common denominator of 8.

$$\left.\begin{array}{l}\text{2 goes into 8 four times}\\ \text{8 goes into 8 one time}\end{array}\right\}\ \text{8 = common denominator}$$

We have determined that 8 is going to be our common denominator, which means that one of the fractions is already good to go.

$$\frac{3}{8} \checkmark$$

But what about 1 over 2, or one-half? We have to turn the one-half into a fraction with 8 as the denominator.

$$\frac{1}{2} \longrightarrow \frac{X}{8}$$

As we calculated above, 2 goes into 8 four times.

$$2 \times 4 = 8$$

That's good for the denominator, but what about the numerator? Well, whatever we do to the one part of the fraction, we must do the same to the other part. This leaves the fraction with the same value. We then have to also multiply the 1 by 4.

$$1 \times 4 = 4$$

If we wanted to do it all in one step, it would look something like this:

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

Now we have something we can work with. Go back to the original equation and replace the $\frac{1}{2}$ with $\frac{4}{8}$.

$$\frac{4}{8} + \frac{3}{8} = \frac{7}{8}$$

Okay, so that works for adding fractions, but what about subtracting fractions? Well, subtracting fractions follows the same principle: if the denominators are not the same, then we have to find a common denominator first before subtracting the two fractions.

Example

Calculate the following:

$$\frac{7}{8} - \frac{13}{16} =$$

Step 1: Find the common denominator. This can get a little tricky when the numbers begin to get larger. As you get more familiar with the patterns in numbers, the answers will come easier. The question we are asking right now is, "What number can both 8 and 16 go into evenly?"

We might even start by seeing if the smaller denominator can go into the larger denominator. In this case, it does.

$$\left.\begin{array}{r}\text{8 goes into 16 two times}\\ \text{16 goes into 16 one time}\end{array}\right\}\ \text{16 = common denominator}$$

The fraction with the common denominator of 16 is already good to go, but we have to work with the fraction with a denominator of 8.

Step 2: Multiply both the numerator and the denominator of ⅞ by 2 to give the fraction the common denominator of 16.

$$\frac{7}{8}\begin{matrix}\times 2\\ \times 2\end{matrix} = \frac{14}{16}$$

Step 3: Subtract the new versions of the fractions.

$$\frac{14}{16} - \frac{13}{16} = \frac{1}{16}$$

PRACTICE QUESTIONS

Answer the following practice questions and check for the video answers. Make sure to put each answer into its lowest terms or a mixed number, if necessary.

Question 1

$$\frac{3}{16} + \frac{5}{8} =$$

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Question 2

$$\frac{5}{8} - \frac{5}{16} =$$

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Question 3

$$\frac{1}{2} + \frac{7}{8} =$$

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://pressbooks.nscc.ca/foodmath/?p=203

Question 4

$$2\frac{1}{2} + 1\frac{7}{8} =$$

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Wait a minute! That last question stepped it up a notch by adding mixed numbers. I know you've already taken a look at the video answer, but let's take a step back and go through the motions of adding and subtracting mixed numbers. We'll start with a short explanation.

ADDING OR SUBTRACTING MIXED NUMBERS

The issue we run into when adding or subtracting mixed numbers is that a mixed number is composed of two separate parts: there is the whole number, and then there is the fraction. When adding the numbers, this can be straightforward, like the following:

$$4\frac{3}{8} + 3\frac{2}{8} = 7\frac{5}{8}$$

Pretty straightforward, right? You simply add the two whole numbers, and then add the fractions. It works out quite nicely. But what about a situation like the next example?

$$4\frac{5}{8} + 3\frac{4}{8} = ?$$

Do you see the issue?

The issue (it's not really an issue) is that, when we add the fractions, we end up with a bigger number in the numerator than in the denominator.

$$4\frac{5}{8} + 3\frac{4}{8} = 7\frac{9}{8}$$

The solution is to change the improper fraction part of the answer into a mixed number, and then add that to the whole number part of the answer.

$$\frac{9}{8} \longrightarrow 1\frac{1}{8}$$

Take the 7 and add it to the mixed number to get our final answer.

$$7 + 1\frac{1}{8} = 8\frac{1}{8}$$

Okay, that seemed pretty straightforward, but what about subtraction? Well, we follow the same rules. Take a look at the following example:

Example

$$8\frac{7}{8} - 6\frac{3}{8} = ?$$

The procedure is similar to that for adding fractions, but instead of adding, we are subtracting. We can break it down into two parts. We start by subtracting the whole numbers, and then follow that up by subtracting the fractions portion.

Step 1: Subtract the whole numbers.

$$8 - 6 = 2$$

Step 2: Subtract the fractions portion of the equation.

$$\frac{7}{8} - \frac{3}{8} = \frac{4}{8} \rightarrow \frac{1}{2}$$

Step 3: Put it all together.

$$8\frac{7}{8} - 6\frac{3}{8} = 2\frac{4}{8} \rightarrow 2\frac{1}{2}$$

Okay, not too hard, right? But take a look at the next example and see if you can figure out the problem that we are going to have as we run through it.

Example

$$5\frac{2}{8} - 3\frac{7}{8} = ?$$

The problem emerges not when you are subtracting the whole numbers, but when you are subtracting the fractions.

$$\frac{2}{8} - \frac{7}{8} = ?$$

We would end up with an answer less than zero. This is not going to work for us. So how do we solve the problem? Well, the answer lies in borrowing, and what we are borrowing from is the whole number, 5. Let's just say we borrow 1 from the 5. This would leave us with 4, and then what? Take a look at the following logic.

$$5 = 4 + 1$$

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

If we go ahead and break the 5 down into 4 and 1, and then split that 1 down into parts of 8, we have a lot more eighths to work with. We can now put everything together to get the following:

$$5\frac{2}{8} = 4 + \frac{8}{8} + \frac{2}{8} = 4\frac{10}{8}$$

We now have numbers we can work with in our original question.

$$4\frac{10}{8} - 3\frac{7}{8} = ?$$

We now follow the same steps as before.

Step 1: Subtract the whole numbers.

$$4 - 3 = 1$$

Step 2: Subtract the fractions portion of the equation.

$$\frac{10}{8} - \frac{7}{8} = \frac{3}{8}$$

Step 3: Put it all together.

$$4\frac{10}{8} - 3\frac{7}{8} = 1\frac{3}{8}$$

PRACTICE QUESTIONS

Add or subtract the following mixed numbers, making sure to put your answer in lowest terms. Check the video answers at the end to see how you did.

Question 1

$$7\frac{3}{16} + 4\frac{5}{16} =$$

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://pressbooks.nscc.ca/foodmath/?p=203

Question 2

$$2\frac{7}{16} + 3\frac{7}{8} =$$

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Question 3

$$8\frac{27}{32} - 1\frac{15}{32} =$$

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Question 4

$$6\frac{5}{16} - 5\frac{5}{8} =$$

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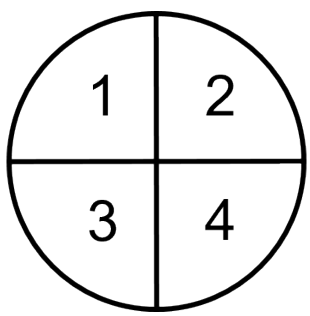
2.C MULTIPLYING FRACTIONS

CHAD FLINN AND MARK OVERGAARD

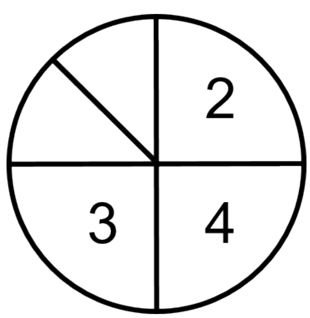
The following equation is an example of multiplying fractions. At first glance, it might look harder than either adding or subtracting fractions, but in reality, it's much easier. What might be tougher to understand is the answer that you get when you multiply fractions.

$$\frac{1}{4} \times \frac{1}{2} = ?$$

We'll take a look at this visually, using a circle cut into parts to work this out. To start, we'll divide the circle into 4 equal parts. One of those parts would equal one-quarter of the circle.



If we were to multiply that ¼ by ½, what we would be doing mathematically is taking ½ of the ¼ piece, or essentially splitting that ¼ into two equal parts. That would end up representing ⅛ of the circle.



Mathematically, it's done like this:

Multiply the numerators together

$$1 \times 1 = 1$$

AND

Multiply the denominators together

$$2 \times 4 = 8$$

What we end up with is this:

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

Example

Let's go back to Abigail, Hanna, and Naomi. They've now completed another level of their schooling and are getting to the end of their apprenticeships. All three are working on the same job, which is a three-storey wood-frame building, and each is responsible for roughing-in 30 suites. They are required to wire ⅙ of those suites every week. One week, Hanna had to miss two days. Therefore, she only worked 3 out of the 5 days, or ⅗ of the time. What fraction of suites would she have been able to rough-in that week, taking into consideration her time away?

Start by writing down the fractions we are going to work with in this situation.

$$\frac{1}{6}\ \text{The amount of suites needed to be completed during a 5-day work week.}$$

$$\frac{3}{5}\ \text{The fraction of time worked during the week, 3 out of 5 days.}$$

Then multiply the two fractions together, sticking to our formula of multiplying the numerators together and then multiplying the denominators together.

$$\text{numerators}\, 1 \times 3 = 3$$
$$\text{denominators}\, 6 \times 5 = 30$$

And that makes the answer:

$$\frac{1}{6} \times \frac{3}{5} = \frac{3}{30}$$

Which can then be reduced to its lowest terms:

$$\frac{3}{30} \rightarrow \frac{1}{10}$$

Here is another example. Let's go through the steps in this one.

Example

$$\frac{5}{8} \times \frac{3}{4} = ?$$

Step 1: Multiply the numerators together.

$$5 \times 3 = 15$$

Step 2: Multiply the denominators together.

$$8 \times 4 = 32$$

Step 3: Put each of the answers in the appropriate place in the fraction.

$$\frac{5}{8} \times \frac{3}{4} = \frac{15}{32}$$

Step 4: Put the answer in lowest terms, if necessary, and change to a mixed number, if necessary. In this question, we are good on both accounts.

$$\text{Final answer} = \frac{15}{32}$$

Up to this point, you may have been thinking that you got this and this is easy, but now, let's step up the difficulty level a bit.

Example

$$4\frac{2}{5} \times 2\frac{1}{4} = ?$$

Before you start, do you see a problem? The problem is that you are now trying to multiply two mixed numbers together. How does that work? Can you just go ahead and try to multiply them as they are? The answer is NO, but the solution to the problem is not that difficult: you just have to take one extra step before going through the process.

The first thing you have to do is change each of the mixed numbers into improper fractions. From that point on, the process is the same.

Step 1: Change each of the mixed numbers into improper fractions. This is the only way to answer this question. You cannot multiply the numbers in the state they are in.

$$4\frac{2}{5} = \frac{22}{5}$$

(5 × 4 + 2 = 22)

$$2\frac{1}{4} = \frac{9}{4}$$

(4 × 2 + 1 = 9)

Step 2: Multiply the numerators together.

$$22 \times 9 = 198$$

Step 3: Multiply the denominators together.

$$5 \times 4 = 20$$

Step 4: Put each of the answers in the appropriate place in the fraction.

$$\frac{22}{5} \times \frac{9}{4} = \frac{198}{20}$$

Step 5: Put the answer in lowest terms, if necessary, and change to a mixed number, if necessary. In this case, we have to do both. We'll start by putting the fraction into lowest terms.

$$\frac{198 \div 2}{20 \div 2} = \frac{99}{10} \quad \text{Lowest terms}$$

Then take that and put it into a mixed number.

$$\frac{99}{10} = 9\frac{9}{10}\,\text{Mixed number}$$

PRACTICE QUESTIONS

Try a couple questions yourself. Make sure to put your answer into lowest terms and, if necessary, turn it back into a mixed number. Check the video answers when you are done to see if you are on the right track.

Question 1

$$\frac{4}{7} \times \frac{3}{8} =$$

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Question 2

$$\frac{6}{11} \times \frac{5}{9} =$$

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Question 3

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

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Question 4

$$7\frac{5}{9} \times 8\frac{5}{7} =$$

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2.D DIVIDING FRACTIONS

CHAD FLINN AND MARK OVERGAARD

Dividing fractions follows similar logic to multiplying fractions. It involves working with the numerators and denominators separately. Once you have done your initial calculations, you put it all together to get your answer. There is a little twist, though, that we'll have to examine as we work through some questions.

Before we get to all that, let's start by revisiting dividing whole numbers, and then we'll work our way up to fractions.

Start with 20 screwdrivers:

Now divide those 20 screwdrivers by 10 (or into groups of 10).

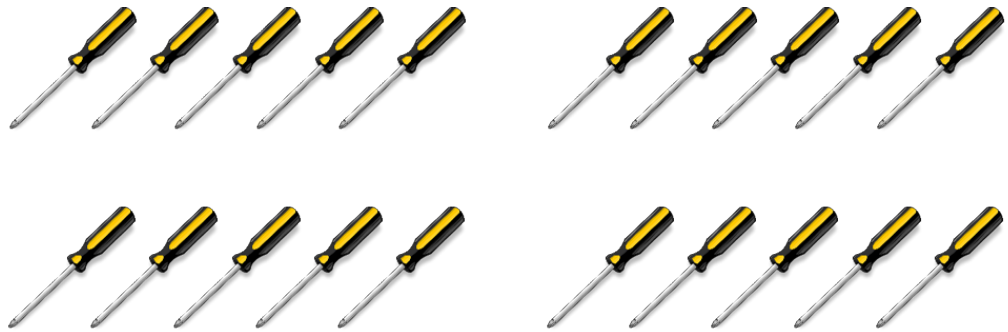
$$20 \div 10 = 2$$

You end up with 2 groups of 10.

Now divide those 20 screwdrivers by 5 (or into groups of 5).

$$20 \div 5 = 4$$

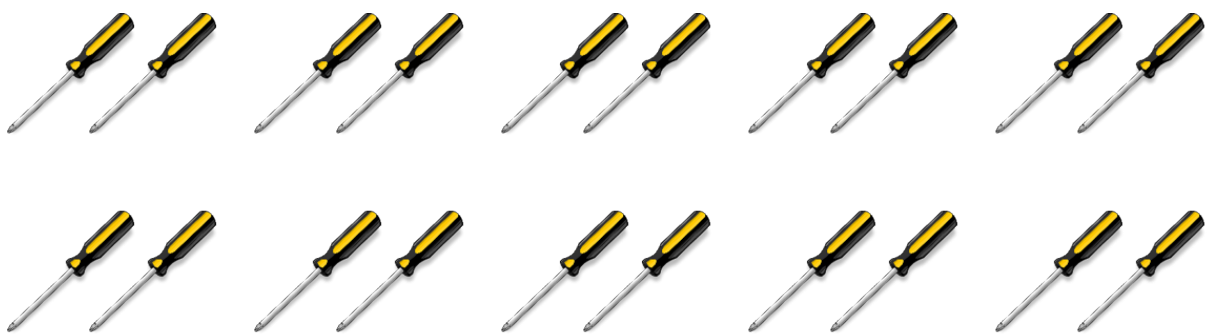
You end up with 4 groups of 5.



Now divide those 20 screwdrivers by 2 (or into groups of 2).

$$20 \div 2 = 10$$

You end up with 10 groups of 2.



Take a look at the math here. Do you see a pattern? What did you come up with? Did you notice that, when you take your original amount (in this case, 20) and divide it by a number that continues to get smaller (10, then 5, then 2), we end up with an answer that gets larger.

$$20 \div 10 = 2$$
$$20 \div 5 = 4$$
$$20 \div 2 = 10$$

Follow this logic into fractions, keeping in mind that fractions are not only less than 10, 5, and 2, but 1. Using this pattern, we determine that dividing the 20 screwdrivers by a number less than 1 would get us a larger answer than if we divided the 20 by 10, 5, or 2.

Try this. Take the 20 screwdrivers, and divide them by ½. What do you think your answer will be?

$$20 \div \frac{1}{2} = ?$$

Following our logic, the answer should be more than 10, and in fact, it is.

$$20 \div \frac{1}{2} = 40$$

This does not mean that we end up with 40 screwdrivers, though. What it means is that we end up with 40 parts of screwdrivers. You have to imagine that each of the screwdrivers were split into 2. Twenty screwdrivers split in half would give us 40 pieces in the end. The question now becomes, how do we do this mathematically? The answer lies in using what is known as a reciprocal. Here is the definition.

Reciprocal: A number that has a relationship with another number such that their product is 1.

This means that, when you take a number such as 5 and then multiply it by its reciprocal, you will end up with an answer of 1. We'll start with the whole number 5. We could also write the number 5 as a fraction.

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

Using our definition of reciprocal, we need to find a number that, when multiplied by $^5/_1$, gives us an answer of 1.

$$\frac{5}{1} \times ? = 1$$

To find the answer, we have to go back to multiplying fractions. Remember that, when we multiply fractions, we just multiply the numerators together and then multiply the denominators together. From this, we can conclude that:

$$\frac{5}{1} \times \frac{1}{5} = 1$$

In the end, to find the reciprocal of a fraction, we simply take the numerator and make it the denominator and take the denominator and make it the numerator. Essentially, we are just flipping the fraction around. Here are some more examples of reciprocals.

$$\frac{3}{8} \text{ and } \frac{8}{3}$$

$$\frac{2}{9} \text{ and } \frac{9}{2}$$

$$\frac{24}{17} \text{ and } \frac{17}{24}$$

Okay, so now that we have the reciprocal issue out of the way, the question then becomes, why do we need reciprocals in the first place? Well, the answer lies in the rule for dividing fractions.

The rule for dividing fractions is you take the first fraction and multiply it by the reciprocal of the second fraction. Yes, you heard that right: to divide, you end up multiplying, but only after first flipping the second fraction around.

Flipping the second fraction around (finding its reciprocal) changes the value of the equation. In order to keep the equation mathematically the same, we have to change the division question into a multiplication question. Take a look at the following example to see how this is done.

Example

$$\frac{1}{2} \div \frac{3}{8} = ?$$

Step 1: Put the question into a form that you can work with. This involves finding the reciprocal of the second fraction and then multiplying it by the first.

$$\text{The reciprocal of } \frac{3}{8} \text{ is } \frac{8}{3}$$

$$\text{Check: } \frac{3}{8} \times \frac{8}{3} = \frac{24}{24} = 1$$

So we end up with:

$$\frac{1}{2} \div \frac{3}{8} \text{ becomes } \frac{1}{2} \times \frac{8}{3} = ?$$

Step 2: Follow the same procedure as we did when multiplying fractions. Multiply the numerators together and then multiply the denominators together.

Multiply the numerators together

$$1 \times 8 = 8$$

Multiply the denominators together

$$2 \times 3 = 6$$

Step 3: Take these answers and put them back into a fraction.

$$\frac{1}{2} \times \frac{8}{3} = \frac{8}{6}$$

Step 4: Put the answer into lowest terms and then into a mixed number, if necessary.

$$\text{Lowest terms} \quad \frac{8 \div 2}{6 \div 2} = \frac{4}{3}$$

$$\frac{4}{3} = 1\frac{1}{3} \text{ Mixed number}$$

Final answer:

$$\frac{1}{2} \div \frac{3}{8} = 1\frac{1}{3}$$

Example

$$\frac{5}{9} \div \frac{7}{4} = ?$$

Step 1: Put the question into a form that you can work with. This involves finding the reciprocal of the second fraction and then multiplying it by the first.

$$\frac{5}{9} \div \frac{7}{4} \text{ becomes } \frac{5}{9} \times \frac{4}{7}$$

Step 2: Multiply the numerators together and then multiply the denominators together.

Multiply numerators together

$$5 \times 4 = 20$$

Multiply denominators together

$$9 \times 7 = 63$$

Step 3: Take these answers and put them back into a fraction.

$$\frac{5}{9} \times \frac{4}{7} = \frac{20}{63}$$

Step 4: Put the answer into lowest terms and then into a mixed number, if necessary. In this case, the answer is both in lowest terms and is a proper fraction already, so we are done.

$$\frac{5}{9} \div \frac{7}{4} = \frac{20}{63}$$

PRACTICE QUESTIONS

Try these practice questions and take a look at the video answers to see how you did.

Question 1

$$\frac{7}{8} \div \frac{7}{16} =$$

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Question 2

$$4\frac{7}{8} \div 2\frac{3}{4} =$$

Note: This one is slightly different from what we have been doing, as it involves dividing mixed numbers. What do you think you are going to have to do when dealing with this?

ANSWER: You have to change the mixed number into an improper fraction first. Then you can work through the question the same way we have been doing before.

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UNIT 3 - RECIPES & FORMULAS: CONVERTING & SCALING

3.1 CONVERTING AND ADJUSTING RECIPES AND FORMULAS

Recipes often need to be adjusted to meet the needs of different situations. The most common reason to adjust recipes is to change the number of individual portions that the recipe produces. For example, a standard recipe might be written to prepare 25 portions. If a situation arises where 60 portions of the item are needed, the recipe must be properly adjusted.

Other reasons to adjust recipes include changing portion sizes (which may mean changing the batch size of the recipe) and better utilizing available preparation equipment (for example, you need to divide a recipe to make two half batches due to a lack of oven space).

CONVERSION FACTOR METHOD

The most common way to adjust recipes is to use the conversion factor method. This requires only two steps: finding a conversion factor and multiplying the ingredients in the original recipe by that factor.

FINDING CONVERSION FACTORS

To find the appropriate conversion factor to adjust a recipe, follow these steps:

1. Note the yield of the recipe that is to be adjusted. The number of portions is usually included at the top of the recipe (or formulation) or at the bottom of the recipe. This is the information that you HAVE.
2. Decide what yield is required. This is the information you NEED.
3. Obtain the conversion factor by dividing the required yield (from Step 2) by the old yield (from Step 1). That is, conversion factor = (required yield)/(recipe yield) or conversion factor = what you NEED ÷ what you HAVE.

Example 5

To find the conversion factor needed to adjust a recipe that produces 25 portions to produce 60 portions, these are steps you would take:

1. Recipe yield = 25 portions
2. Required yield = 60 portions
3. Conversion factor
    1. = (required yield) ÷ (recipe yield)

2. = 60 portions ÷ 25 portions
3. = 2.4

If the number of portions and the size of each portion change, you will have to find a conversion factor using a similar approach:

1. Determine the total yield of the recipe by multiplying the number of portions and the size of each portion.
2. Determine the required yield of the recipe by multiplying the new number of portions and the new size of each portion.
3. Find the conversion factor by dividing the required yield (Step 2) by the recipe yield (Step 1). That is, conversion factor = (required yield)/(recipe yield).

Example 6

For example, to find the conversion factor needed to change a recipe that produces 20 portions with each portion weighing 150 g into a recipe that produces 60 portions with each portion containing 120 g, these are the steps you would take:

1. Old yield of recipe = 20 portions × 150 g per portion = 3000 g
2. Required yield of recipe = 40 portions × 120 g per portion = 4800 g
3. Conversion factor
    1. = required yield ÷ old yield
    2. = 4800 ÷ 3000
    3. = 1.6

Key Takeaway

To ensure you are finding the conversion factor properly, remember that if you are increasing your amounts, the conversion factor will be greater than 1. If you are reducing your amounts, the factor will be less than 1.

ADJUSTING RECIPES USING CONVERSION FACTORS

Now that you have the conversion factor, you can use it to adjust all the ingredients in the recipe. The procedure is to multiply the amount of each ingredient in the original recipe by the conversion factor. Before you begin, there is an important first step:

Before converting a recipe, express the original ingredients by weight whenever possible.

Converting to weight is particularly important for dry ingredients. Most recipes in commercial kitchens express the ingredients by weight, while most recipes intended for home cooks express the ingredients by volume. If the amounts of some ingredients are too small to weigh (such as spices and seasonings), they may be left as volume measures. Liquid ingredients also are sometimes left as volume measures because it is easier to measure a litre of liquid than it is to weigh it. However, a major exception is measuring liquids with a high sugar content, such as honey and syrup; these should always be measured by weight, not volume.

Converting from volume to weight can be a bit tricky and may require the use of tables that provide the approximate weight of different volume measures of commonly used recipe ingredients. Once you have all ingredients in weight, you can then multiply by the conversion factor to adjust the recipe.

When using U.S. or imperial recipes, often you must change the quantities of the original recipe into smaller units. For example, pounds may need to be expressed as ounces, and cups, pints, quarts, and gallons must be converted into fluid ounces.

CONVERTING A U.S. MEASURING SYSTEM RECIPE

The following example will show the basic procedure for adjusting a recipe using U.S. measurements.

Example 7

Adjust a standard formulation (Table 13) designed to produce 75 biscuits to have a new yield of 300 biscuits.

Table 13: Table of ingredients for conversion recipe in U.S. system

Ingredient	Amount
Flour	3¼ lbs.
Baking Powder	4 oz.
Salt	1 oz.
Shortening	1 lb.
Milk	6 cups

Solution

1. Find the conversion factor.
    1. conversion factor = new yield/old yield
    2. = 300 biscuits ÷ 75 biscuits
    3. = 4
2. Multiply the ingredients by the conversion factor. This process is shown in Table 14.

Table 14: Table of ingredients for recipe adjusted in U.S. system

Ingredient	Original Amount (U.S)	Conversion factor	New Ingredient Amount
Flour	3¼ lbs.	4	13 lbs.
Baking powder	4 oz.	4	16 oz. (= 1 lb.)
Salt	1 oz.	4	4 oz.
Shortening	1 lb.	4	4 lbs.
Milk	6 cups	4	24 cups (= 6 qt. or 1½ gal.)

CONVERTING AN IMPERIAL MEASURING SYSTEM RECIPE

The process for adjusting an imperial measure recipe is identical to the method outlined above. However, care must be taken with liquids as the number of ounces in an imperial pint, quart, and gallon is different from the number of ounces in a U.S. pint, quart, and gallon. (If you find this confusing, refer back to Table 7 and the discussion on imperial and U.S. measurements.)

CONVERTING A METRIC RECIPE

The process of adjusting metric recipes is the same as outlined above. The advantage of the metric system becomes evident when adjusting recipes, which is easier with the metric system than it is with the U.S. or imperial system. The relationship between a gram and a kilogram (1000 g = 1 kg) is easier to remember than the relationship between an ounce and a pound or a teaspoon and a cup.

Example 8

Adjust a standard formulation (Table 15) designed to produce 75 biscuits to have a new yield of 150 biscuits.

Table 15: Table of ingredients for conversion recipe in metric system

Ingredient	Amount
Flour	1.75 kg
Baking powder	50 g
Salt	25 g
Shortening	450 g
Milk	1.25 L

Solution

1. Find the conversion factor.
    1. conversion factor = new yield/old yield
    2. = 150 biscuits÷75 biscuits
    3. = 2

2. Multiply the ingredients by the conversion factor. This process is shown in Table 16.

Table 16: Table of ingredients for recipe adjusted in metric system

Ingredient	Amount	Conversion Factor	New Amount
Flour	1.75 kg	2	3.5 kg
Baking powder	50 g	2	100 g
Salt	25 g	2	50 g
Shortening	450 g	2	900 g
Milk	1.25 L	2	2.5 L

CAUTIONS WHEN CONVERTING RECIPES

Although recipe conversions are done all the time, several problems can occur. Some of these include the following:

- Substantially increasing the yield of small home cook recipes can be problematic as all the ingredients are usually given in volume measure, which can be inaccurate, and increasing the amounts dramatically magnifies this problem.
- Spices and seasonings must be increased with caution as doubling or tripling the amount to satisfy a conversion factor can have negative consequences. If possible, it is best to under-season and then adjust just before serving.
- Cooking and mixing times can be affected by recipe adjustment if the equipment used to cook or mix is different from the equipment used in the original recipe.

The fine adjustments that have to be made when converting a recipe can only be learned from experience, as there are no hard and fast rules. Generally, if you have recipes that you use often, convert them, test them, and then keep copies of the recipes adjusted for different yields, as shown in Table 17.

RECIPES FOR DIFFERENT YIELDS OF CHEESE PUFFS

Table 17.1: Cheese Puffs, Yield 30

Ingredient	Amount
Butter	90 g
Milk	135 mL
Water	135 mL
Salt	5 mL
Sifted flour	150 g
Large eggs	3
Grated cheese	75 g
Cracked pepper	To taste

Table 17.2: Cheese Puffs, Yield 60

Ingredient	Amount
Butter	180 g
Milk	270 mL
Water	270 mL
Salt	10 mL
Sifted flour	300 g
Large eggs	6
Grated cheese	150 g
Cracked pepper	To taste

Table 17.3: Cheese Puffs, Yield 90

Ingredient	Amount
Butter	270 g
Milk	405 mL
Water	405 mL
Salt	15 mL
Sifted flour	450 g
Large eggs	9
Grated cheese	225 g
Cracked pepper	To taste

Table 17.4: Cheese Puffs, Yield 120

Ingredient	Amount
Butter	360 g
Milk	540 mL
Water	540 mL
Salt	20 mL
Sifted flour	600 g
Large eggs	12
Grated cheese	300 g
Cracked pepper	To taste

BAKER'S PERCENTAGE

Many professional bread and pastry formulas are given in what is called **baker's percentage**. Baker's percentage gives the weights of each ingredient relative to the amount of flour (Table 18). This makes it very easy to calculate an exact amount of dough for any quantity.

Table 18: A formula stated in baker's percentage

Ingredient	%	Total	Unit
Flour	100.0%	15	kg
Water	62.0%	9.3	kg
Salt	2.0%	0.3	kg
Sugar	3.0%	0.45	kg
Shortening	1.5%	0.225	kg
Yeast	2.5%	0.375	kg
Total weight:	171.0%	25.65	kg

To convert a formula using baker's percentage, there are a few options:

If you know the percentages of the ingredients and amount of flour, you can calculate the other ingredients by multiplying the percentage by the amount of flour to determine the quantities. Table 19 shows that process for 20 kg flour.

Table 19: Baker's percentage formula adjusted for 20 kg flour

Ingredient	%	Total	Unit
Flour	100.0%	20	kg
Water	62.0%	12.4	kg
Salt	2.0%	0.4	kg
Sugar	3.0%	0.6	kg
Shortening	1.5%	0.3	kg
Yeast	2.5%	0.5	kg
Total weight:	171.0%	34.20	kg

If you know the ingredient amounts, you can find the percentage by dividing the weight of each ingredient by the weight of the flour. Remember, flour is always 100%. For example, the percentage of water is $6.2 \div 10 = 0.62 \times 100$ or 62%. Table 20 shows that process for 10 kg of flour.

Table 20: Baker's percentages given for known quantities of ingredients

Ingredient	%	Total	Unit
Flour	100.0%	10	kg
Water	62.0%	6.2	kg
Salt	2.0%	0.2	kg
Sugar	3.0%	0.3	kg
Shortening	1.5%	0.15	kg
Yeast	2.5%	0.25	kg

Example 9

Use baker's percentage to find ingredient weights when given the total dough weight.

For instance, you want to make 50 loaves at 500 g each. The weight is 50 × 0.5 kg = 25 kg of dough.

You know the total dough weight is 171% of the weight of the flour.

To find the amount of flour, 100% (flour) is to 171% (total %) as *n* (unknown) is to 25 (Table 21). That is,

1. $100 \div 171 = n \div 25$
2. $25 \times 100 \div 171 = n$
3. $14.62 = n$

Table 21: Formula adjusted based on total dough weight

Ingredient	**%**	**Total**	**Unit**
Flour	100.0%	14.62	kg
Water	62.0%	9.064	kg
Salt	2.0%	0.292	kg
Sugar	3.0%	0.439	kg
Shortening	1.5%	0.219	kg
Yeast	2.5%	0.366	kg
Total weight:	171.0%	25.00	kg

As you can see, both the conversion factor method and the baker's percentage method give you ways to convert recipes. If you come across a recipe written in baker's percentage, use baker's percentage to convert the recipe. If you come across a recipe that is written in standard format, use the conversion factor method.

MATH FOUNDATION FOR UNIT 3: DECIMALS

3.A UNDERSTANDING DECIMAL NOTATION

CHAD FLINN AND MARK OVERGAARD

We started by going through whole numbers, then we moved onto fractions, and now we will look at decimals.

We start this story with Chad. Now, Chad is not an apprentice, like the people in the first two stories, but rather someone who received his Red Seal Electrical Ticket a number of years ago. He then went on to start his own electrical company, which he still runs today.

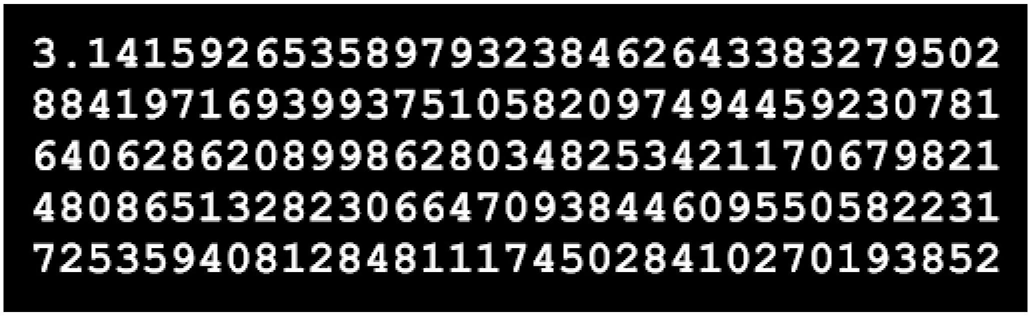
After owning his own business for several years, Chad recognized the fact that apprentices coming through the system could use some advice about starting and running a company, especially when it came to the money portion. As Chad has some experience in this, he decided to start a course for apprentices wishing to start their own businesses.

When dealing with numbers, we don't always have the luxury of working with just whole numbers. If we referred back to the last chapter and looked at fractions, we would see that a fraction represents a part of a whole number. Decimals are the same in that they represent a part of a whole number. The difference is that decimals are written with a different notation than fractions. Decimal notation allows us to visually quantify how much of a whole number we are dealing with.

In his first class, Chad starts off by talking about the price of tools and materials. He starts with a hammer priced at $12.47. Note that the cost of the hammer is not exactly $12, but a little more than $12. This is where decimals come into play. The numbers after the point (.) , also known as the decimal point, are called decimals.

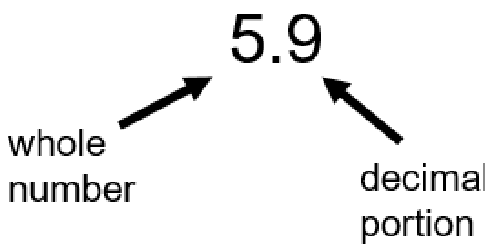
Each dollar contains 100 cents. In fact, the word "cent" means 100. Think of a century: it has 100 years in it. All decimals are based on the number 10 and can be referred to as base 10. These numbers include 10, 100, 1000, 10000, and so on. If we were to relate this to fractions, we would be dealing with fractions that have a denominator of 10, 100, 1000, 10000, and so on.

Although we only have two decimal places to worry about when dealing with money, we can continue a decimal on for as long as we want. For instance, the number pi (3.14 or π) actually continues on forever and has no ending. Check it out:



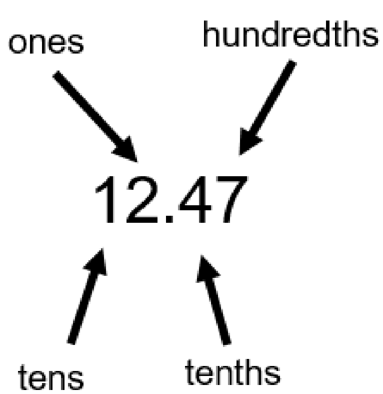
This just shows pi to the first few dozen decimal places, but there are lots more.

What we need to do is get an understanding of the decimal system and how it works. Take a look at the following number.

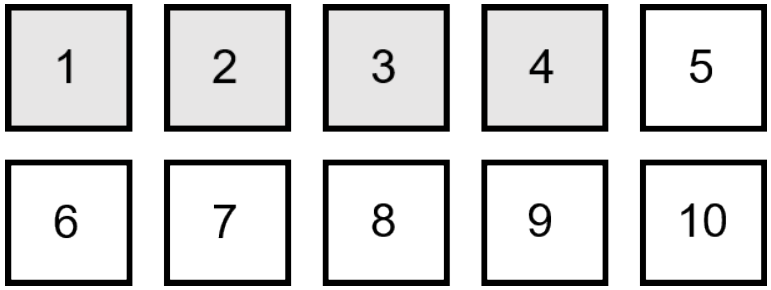


Back in Chapter 1, we dealt with the place value system for whole numbers (see The Place Value System). Decimals follow a similar pattern that starts with the first number to the right of the decimal. In our example of 5.9, the pattern would begin with the 9.

Back to Chad. In Chad's lecture, he stresses the importance of detailed accounting when dealing with your own business. Now, we all know that there are 100 cents in a dollar, and making sure that you get the cents correct when accounting is important. Rounding up or down to the nearest dollar and being "close enough" won't cut it. Exact dollar and cent amounts are important, so Chad deals with numbers that go to the second decimal place. Take a look at the number below (which we could assume represents dollars and cents) to see what places the digits are in before and after the decimal place. Let's use the hammer example of $12.47.



Think of the 0.47 as it relates to money. It would represent 47 cents out of a possible 100 cents. What does the 4 represent by itself? Well, in terms of a dollar, it refers to 40 cents, or 40 out of 100. This is all good, except for the fact that the 4 is actually in what is referred to as the tenths place. What the number is indicating is that we have 4 out of a possible 10 parts. The tenths place can be looked at as being split up into 10 parts, and we have 4 full parts.



The next step here is to visualize what the 7 is all about. The 7 is in the hundredths place, which means that we have 7 out of a possible 100.

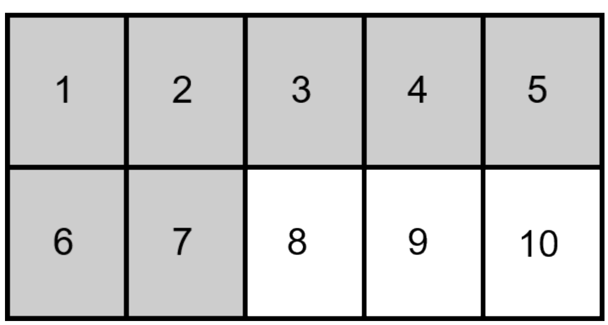
The idea here is to take each box and break it into even smaller parts. The first four boxes are already shaded grey because they represent 4 complete boxes or 40 cents. What we do next is take the fifth box and break it into 10 parts.

Question: If we were to break all 10 boxes into 10 small parts, how many would we have?

$$10 \times 10 = 100$$

We would end up with 100 parts, or we could look at it like 100 cents. Now, take the fifth box out, divide that box into 10 parts, and fill up 7 of them.

Box 5



Imagine that each of the original 10 boxes are split into 10 even parts. What gets crazier is that we could then take each of those 100 boxes and split them into another 10 parts each. What this would leave us with is a number that takes us to the thousandths place, because we would be splitting things up into 1000 parts. What we are really doing with decimals is taking a whole number and breaking it down into parts, similar to fractions. In fact, if we were to look at decimals like fractions, this is how we would think about it:

$$\frac{1}{10} = 0.1$$

$$\frac{1}{100} = 0.01$$

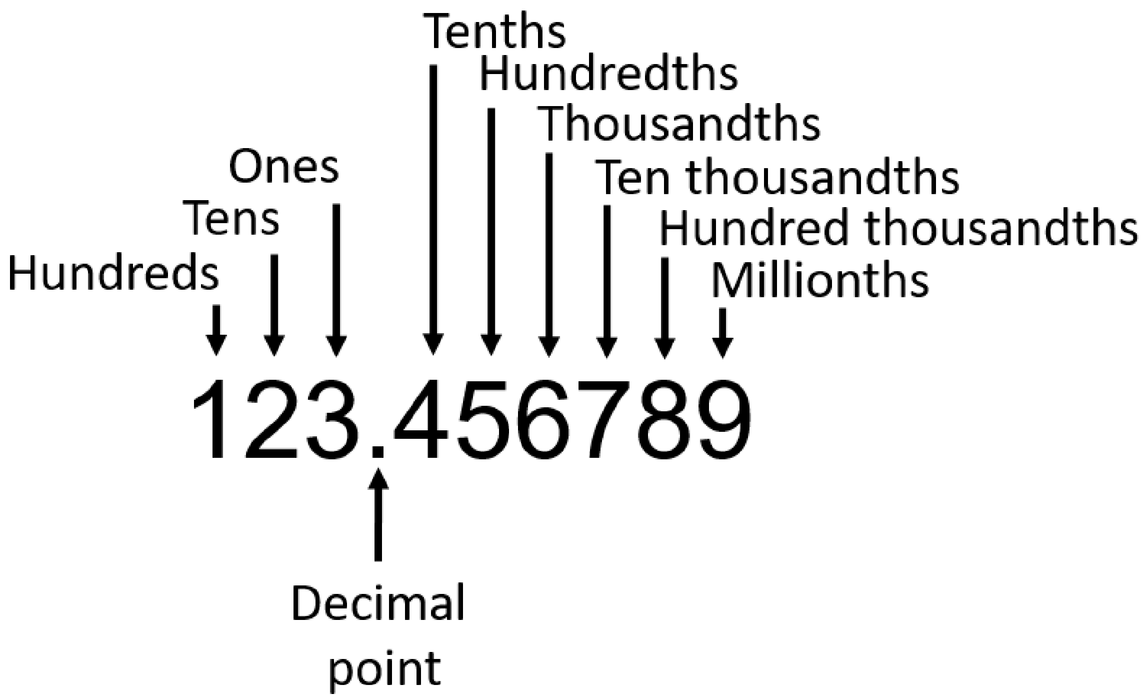
$$\frac{1}{1000} = 0.001$$

Now that we have the first three digits after the decimal point figured out, let's work our way even further. Take a look at the number below. To the left of the decimal point is the whole number, and to the right is the decimal or part of a whole number.

$$123.456789$$

Note: 1, 2, and 3 are all part of the whole number, and 4, 5, 6, 7, 8, and 9 are all part of the decimal. Using the place value system for both whole numbers and decimals, we would end up with the following:

- 1 = hundreds place
- 2 = tens place
- 3 = ones place
- (.) = decimal
- 4 = tenths place
- 5 = hundredths place
- 6 = thousandths place
- 7 = ten thousandths place
- 8 = hundred thousandths place
- 9 = millionths place



A number with all its digits categorized according to the place value system.

Let's go through a couple quick examples, just to make sure we are all on the same page.

Example

In the number below, indicate which digit is in the thousandths place.

$$57.29652$$

The easiest way to do this is to write out the number, and then, starting from the left, indicate the place value of each of the digits.

- 5 = tens place
- 7 = ones place
- 2 = tenths place
- 9 = hundredths place
- **6 = thousandths place**
- 5 = ten thousandths place
- 2 = hundred thousandths place

The 6 is in the thousandths place.

Try another example.

Example

In the number below, indicate which digit is in the hundred thousandths place.

$$369.246813$$

Once again, to find the answer, write down the number, and then indicate the place value of each of the digits.

- 3 = hundreds place
- 6 = tens place
- 9 = ones place
- 2 = tenths place
- 4 = hundredths place
- 6 = thousandths place
- 8 = ten thousandths place
- **1 = hundred thousandths place**
- 3 = millionths place

The 1 is in the hundred thousandths place.

MATH FOUNDATION FOR UNIT 4: PERCENTAGES

4.A WHAT IS A PERCENT ANYWAY?

CHAD FLINN AND MARK OVERGAARD

Remember the last time you wrote a test? What percentage did you receive? If you got 30 out of 35, could you calculate the percentage? How about finding out the percentage of students who like math? How would you calculate that number?

Percentages are used in many different areas of our lives. For example, we hear about the interest rate or unemployment rate, the percentage of people who prefer hockey over football or the percentage of people who prefer science over math. Percentages are a useful way of making comparisons. This chapter will deal with percentages: how we get them, and how we can use them.

WHAT EXACTLY IS A PERCENT?

The word “per cent” means “out of 100.” In math language, when we say “out of” we are really saying “divided by.” Therefore, when we are dealing with percent, the basis of it is to divide by 100. The word “cent” on its own refers to 100. The word cent is actually Latin for 100. This relates to many things. The easiest might be the word century, which means 100 years.

You can also think of words like centimetre. There are 100 centimetres (cm) in 1 metre. Or, how about the word cent when it comes to money? In money, 100 cents equals 1 dollar.

Are you beginning to see the trend here?

Now, think about the last time you wrote a test out of 100. Let’s say you scored very well and scored 92 out of 100. That would be the same as saying you received 92 percent.

Written mathematically, it looks like this:

$$92\%$$

The symbol % means percent and can be used in place of writing the actual word percent. You can find this symbol on your computer keyboard, generally on the same key as one of the numbers. On my keyboard, the percent symbol is on the same key as the number 5. To get the % symbol, you would press the [Shift] and [5] keys at the same time.

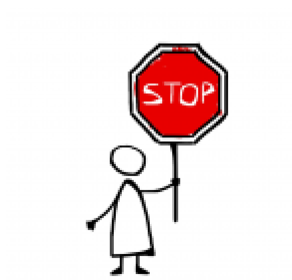
The following is an example of percent.

According to a recent survey by BCIT Piping Foundation Instructors, 25% of students coming into the Piping Foundation Program would like to get into the plumbing trade, 20% would like to get into the steamfitting trade, and 10% would like to get into the gasfitting trade. The remaining 45% of students are undecided when they begin the program. If you add up those percentages, they equal 100.

Percentage of students indicating which trades they would like to pursue

Piping Trade	Percentage
Plumbing	25%
Gasfitting	10%
Undecided	45%
Total	100%

What the numbers reveal is that if you took 100 students and asked them which piping trade they were looking to get into, on average, 25 would say plumbing, 20 would say steamfitting, 10 would say gasfitting, and 45 would say that they are undecided. **(Note: These are generalizations, not actual facts.)**



Stop here for one second. Does that mean that every time you have a survey, and you are looking to find percentages, you need to have 100 participants?

No, it doesn't.

We'll go through that in just a bit, but for now just know that percentages are based on 100 but don't necessarily reflect that we have 100 people, items, or questions, etc.

4.B RATIOS AND FRACTIONS AND HOW THEY RELATE TO PERCENTAGE

CHAD FLINN AND MARK OVERGAARD

What does a ratio have to do with percentage? What does a fraction have to do with percentage? What is a ratio? These are all good questions, and we'll answer them here. Percentages, ratios, and fractions are all very similar and can be used to represent numbers in different ways, but with similar outcomes.

We already went through fractions in a past chapter, so we know what those are all about. We should take a bit of time to talk about ratios and what they are.

Mathematically speaking, a ratio is a relationship between two numbers. If we were to once again order a pizza and eat 3 of the 8 slices, we could look at that as a ratio. We ate three-eighths of the pizza. Written as a ratio, this looks like:

$$3 : 8$$

Notice how the ratio is written. It has its own style, just like a fraction does. A ratio of 3:8 means that we have eaten 3 of the 8 pieces in the pizza. We could also write a ratio that identified how many pieces of the pizza were eaten and how many were not eaten. The ratio for that would look like:

$$3 : 5$$

In this case, 3 pieces of the pizza were eaten while 5 pieces were not. Regardless of which way we describe our pizza eating, what we are dealing with is the relationship between two numbers.

Here is another example: let's say we are on a job site, and we have to install some pipe. We have 42 feet of plastic pipe and 79 feet of steel pipe to install. What is the ratio of plastic pipe to steel pipe that we need to install?

The answer:

$$42 : 79$$

Another question might be how much of the pipe is plastic in relation to how much total pipe we have. In this case, the ratio would look like:

$$42 : 121$$

In this case, the 121 is derived from adding the plastic pipe and the steel pipe lengths together.

$$42 + 79 = 121$$

At this point, you might be thinking that this looks and sounds familiar, and you would be correct. Ratios are similar to fractions, and each ratio can be written as a fraction.

$$\frac{42}{121}$$

We would say that 42 feet out of a total of 121 feet of pipe is plastic.

All right: we've added a few new things to our math library here, but you might be asking right about now, "Aren't we dealing with percentages in this chapter? How does all this ratio and fraction stuff relate to percentages?"

The idea is we can take these ratios or fractions and turn them into percentages by making the ratio or fraction out of 100. In truth, we don't even need to make a ratio or fraction out of 100 to do this, but it's a good place to start our understanding of the math behind the whole process.

We are at a point where we can finally introduce you to some new people in the story. For the story of percentage, we're going to use apprentices from carpentry, electrical, and plumbing, in addition to statistics.

Note: all the statistics are just made up.

A trades college teaches many trades, including carpentry, electrical, and plumbing. There are currently 97 carpentry apprentices, 123 electrical apprentices, and 80 plumbing apprentices at the college.

The college likes to keep statistics on apprentices, including what percentage of all the apprentices each of the three trades holds. The question is, how do we go about this?

The first thing we should do is add up the total number of apprentices in each of the three trades.

$$97 + 123 + 80 = 300$$

What we can do now is put each of the apprentice totals into both a ratio and a fraction of the whole.

Carpentry

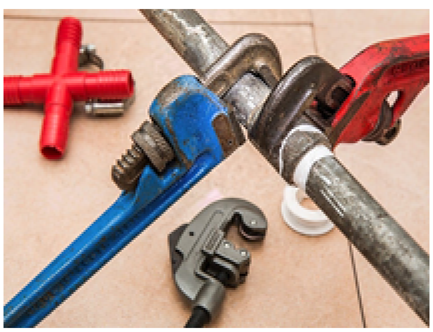
97:300 $\frac{97}{300}$

Ratio Fraction

Electrical

123:300 $\frac{123}{300}$

Ratio Fraction



Plumbing

80:300 $\frac{80}{300}$

Ratio Fraction

If percentages are based on 100, then we have to translate the ratio and the fraction into forms based on 100. In other words, we have to make it so that the number on the right in the ratio is 100 and the denominator in the fraction is 100. For this, we have to go back to our work with fractions.

We'll start with the 97 carpentry apprentices. We have 97 apprentices out of a total of 300. Our goal here is to get this fraction down to a point where the denominator is 100.

$$\frac{97}{300} \longrightarrow \frac{?}{100}$$

We are essentially reducing the fraction. Luckily for us, going from 300 down to 100 is quite easy. We just divide the denominator by 3, and then also divide the numerator by 3.

$$\frac{97 \div 3}{300 \div 3} = \frac{32.33}{100}$$

We could now write this number as a ratio.

$$32.33 : 100$$

What we end up with is the fact that 32.33% of the trades apprentices are carpentry apprentices. Once we find out the number of carpentry students per 100 students, we automatically have our percentage. In just a bit, we'll talk about working with numbers that don't give us a nice even number of 100 and simply translate to percentage in one step. But for now, let's continue on with our apprentices.

Example

Find the percentage of electrical students.

Step 1: Put the numbers into an equation that we can work with. In this case, put the numbers into a fraction.

$$\frac{123}{300}$$

Step 2: Turn the fraction into one with a denominator of 100.

$$\frac{123 \div 3}{300 \div 3} = \frac{41}{100}$$

As a ratio, we would have:

$$41 : 100$$

And finally, as a percentage, we would get:

$$41$$

Practice Question

Now calculate the percentage of plumbing apprentices. Check the video to see if your answer is correct.

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://pressbooks.nscc.ca/foodmath/?p=253

The next step actually makes the whole process of finding percentages easier. Remember that "percent" really means out of 100, and in the last section, we took our numbers and made them into fractions with denominators of 100. In this section, we skip that whole procedure and just take the numbers we have and work with them as they are.

We'll go back to our apprentices for this. Out of the total of 97 carpentry apprentices, there are 57 with a grade of "A" or "B." What percentage of them have an "A" or "B"? We could go back to our old ways and get to a fraction with a denominator of 100, or we could simply divide the 57 by the 97.

Mathematically, it looks like this:

$$57 \div 97 = 0.59$$

Now take the 0.59 and turn that into a percentage by multiplying the 0.59 by 100. This moves the decimal point 2 spots to the right and leaves us with a whole number. It's as simple as that.

$$0.59 \times 100 = 59$$

Example

Using the same method we just used with the carpentry apprentices, find the percentage of plumbing students in the trades college.

Step 1: Write down the equation in a format we can use.

$$80 \div 300 = ?$$

Step 2: Work this out in your head. Just kidding: grab your calculator and plug the numbers in.

$$80 \div 300 = 0.267$$

Step 3: Multiply the answer by 100 to put it into a percentage.

$$0.267 \times 100 = 26.7$$

PRACTICE QUESTIONS

Try these practice questions. You can either change each number into a fraction with a denominator of 100, or you can divide one number by the other. The choice is yours, but the video answers will go through both ways.

Question 1

The electrical students are wiring an electrical project as part of their practical mark. The students must receive a minimum of 35 out of a possible 50 marks. What percentage is that?

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://pressbooks.nscc.ca/foodmath/?p=253

Question 2

The plumbing students have been asked to move a bunch of pipe from one side of the shop to the other. There are 279 pieces of cast iron pipe that have to be moved. At the end of the day, they have moved 222 pieces. What percentage of the pipe have they moved?

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://pressbooks.nscc.ca/foodmath/?p=253

Question 3

Referring to question 2, what percentage of the pipe do the students still have to move in relation to the original amount?

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://pressbooks.nscc.ca/foodmath/?p=253

UNIT 4 - YIELD: FACTORS, PERCENTAGES & COSTING

4.1 CONTROLLING FOOD COSTS

Food service establishments are businesses. In order to stay in business, everyone involved with the enterprise should have at least a basic idea of how costs are determined and how such costs have an impact on an operating budget.

Food costs are controlled by five standards to which all employees and managers must adhere:

- Standard purchase specifications
- Standard recipes
- Standard yields
- Standard portion sizes
- Standard portion costs

To calculate the cost of each item, you need to understand the relationship between **standardized recipes**, standard portions, and yield tests. All of these play a role in calculating the cost of each item on your menu.

After goods are ordered, there should be no surprises when the goods arrive. The more specific the order, the less the chance of receiving supplies that are too high in price, too poor in quality, or too many in number.

Specifications can include brand names, grades of meat, product size, type of packaging, container size, fat content, count per kilogram, special trimming, and so on. The specifications should be specific, realistic, and easy to verify.

Precise specifications can:

- Reduce purchasing costs as higher quality products need not be accepted
- Ensure constant quality in menu items
- Allow for accurate competitive bidding among suppliers and so reduce costs

Specifications usually do not include general delivery procedures or purchase price. Directions and prices can change quickly. Specifications should be well thought out and are usually not subject to quick change.

STANDARDIZED RECIPES

A standardized recipe is one that holds no surprises. A standardized recipe will produce a product that is close to identical in taste and yield every time it is made, no matter who follows the directions. A standardized recipe usually includes:

- A list of all ingredients including spices and herbs
- Exact quantities of each ingredient (with the exception of spices that may be added to taste)
- Specific directions for the order of operations and types of operations (e.g., blend, fold, mix, sauté)
- The size and number of portions the recipe will produce

STANDARD YIELDS

The **yield** of a recipe is the number of portions it will produce. Standard yields for high-cost ingredients such as meat are determined by calculating the cost per cooked portion. For example, a 5 kg roast might be purchased for $17 a kilogram. The cooked roast is to be served in 250 g portions as part of a roast beef dinner. After trimming and cooking, the roast will not weigh 5 kg, but significantly less. By running a **yield test**, the cost per portion and unit weight, and the standard yield and yield percentage, can be determined.

STANDARD PORTIONS

A standard recipe includes the size of the portions that will make up a serving of the recipe. Controlling portion size has two advantages in food management: **portion costs** for the item will be consistent until ingredient or labour costs increase, and customers will receive consistent quantities each time they order a given plate or drink.

Standard portions mean that every plate of a given dish that leaves the kitchen will be almost identical in weight, count, or volume. Only by controlling portions is it possible to control food costs. If one order of bacon and eggs goes out with six rashers of bacon and another goes out with three rashers, it is impossible to determine the actual cost of the menu item.

Adhering to the principles of standard portions is crucial to keeping food costs in line. Without portion control, there is no consistency. This not only could have drastic effects on your food costs (having no real constant costs to budget for) but also on your customers. Customers appreciate consistency. They expect that the food you prepare will taste good, be presented properly, and be the same portion size every time they order it. Consider how the customer would feel if the portion size fluctuated with the cook's mood. A cook's bad mood might mean a smaller portion or, if the cook was in a good mood because the work week was over, the portion might be very large. It may be hard to grasp the importance of consistency with one single portion, but consider if fast-food outlets did not have portion control. Their costs as well as their ordering and inventory systems would be incredibly inaccurate, all of which would impact negatively on their **profit** margin.

Strict portion control has several side benefits beyond keeping costs under control. First, customers are more satisfied when they can see that the portion they have is very similar to the portions of the same dish they can see around them. Second, servers are quite happy because they know that if they pick up a dish from the kitchen, it will contain the same portions as another server's plate of the same order.

Simple methods to control portion include weighing meat before it is served, using the same size juice glasses when juice is served, counting items such as shrimp, and portioning with scoops and ladles that hold a known volume. Another method is using convenience products. These products are received usually frozen and are ready to cook. Portions are consistent in size and presentation and are easily costed out on a per unit basis. This can be helpful when determining the standard portion costs.

Note: Using convenience products is usually more costly than preparing the item in-house. However, some chefs and managers feel that using premade convenience products is easier than hiring and training qualified staff. But always keep in mind that if the quality of the convenience item is not comparable to an in-house made product, the reputation of the restaurant may suffer.

Standard portions are assured if the food operation provides and requires staff to use such tools as scales, measured ladles, and standard size scoops. Many operations use a management portion control record for menu items, similar to the one shown in Figure 8. The control record is posted in the kitchen so cooks and those who plate the dishes know what constitutes standard portions. Some operations also have photographs of each item posted in the kitchen area to remind workers what the final product should look like.

Figure 8: Portion control record

Portion Control Record

Item	Purchased Size	Yield %	Cooked Yield	Portion Size	No. of Portions
Baked ham	6-7 kg	50%	3.0-3.5 kg		
Lunch				50 g	60-70
Dinner				85 g	35-41
Prime rib	9-12 kg	40%	3.6-4.8 kg	150 g	24-32
Fillet of sole	500 g	100%	500.0 g		
Lunch				50 g	10
Dinner				85 g	6
Potatoes:	50 kg				
• Roasted Potatoes		75%	Peeled – 37.5 kg	100 g	375
• French fries		56%	Peeled – 28.0 kg	100 g	280
Daily veg	5 kg				
Green beans		80%	Trimmed – 4 kg	50 g	80
Carrots		80%	Peeled – 4 kg	50 g	80

STANDARD PORTION COSTS

A standard recipe served in standard portions has a standard portion cost. A standard portion cost is simply the cost of the ingredients (and sometimes labour) found in a standard recipe divided by the number of portions produced by the recipe. Standard portion costs change when food costs change, which means that standard portion costs should be computed and verified regularly, particularly in times of high inflation. If market conditions are fairly constant, computing standard portion costs need not be done more than every few months.

Details about recipe costs are not usually found on a standard recipe document but on a special recipe detail and cost sheet or database that lists the cost per unit (kilogram, pound, millilitre, ounce, etc.) and the cost per amount of each ingredient used in the recipe or formula.

The standard portion cost can be quickly computed if portions and recipes are standardized. Simply determine the cost of each ingredient used in the recipe and ingredients used for accompaniment or garnish.

The ingredients in a standard recipe are often put on a recipe detail sheet (Figure 9). The recipe detail sheet differs from the standard recipe in that room is provided for putting the cost of each ingredient next to the ingredient. Recipe detail sheets often have the cost per portion included as part of their information, and need to be updated if ingredient costs change substantially. They can also be built in a POS system database or spreadsheet program that is linked to your inventory to allow for the updating of recipe costs as ingredient costs change.

Figure 9: Menu item – Seafood Newburg

Yield: 10 portions
Portion size: 125 g of seafood
Selling price: $12.99
Cost/portion: $4.07
Food cost %: 31.3%

Recipe detail and cost sheet

Ingredients	Quantity	Units	Cost/Unit	Extension
Lobster meat	500 g	kg	$38.00	$19.00
Scallops	250 g	kg	$25.00	$6.25
Shrimps	250 g	kg	$14.00	$3.50
Sole	250 g	kg	$8.50	$2.13
Cream, heavy	250 mL	L	$4.00	$1.00
Fish Velouté	750 mL	L		$1.00
Butter	250 g	500 g	$2.85	$1.43
Pepper and salt				
Paprika	5 g			$0.15
Sherry	250 mL	750 mL	$12.00	$4.00
Egg yolks	6	12	$2.00	$1.00
Patty shells	10	each	$0.12	$1.20
Total				$40.66

Procedure: Quarter the scallops, dice the lobster meat, halve the shrimps, and chop the sole before sautéing well in melted butter. Add sherry and simmer for a few minutes. Add the fish velouté sauce and paprika and continue to simmer. Combine the egg yolks and the heavy cream before adding them slowly to the simmering pan. Season to taste with salt and white pepper. Serve in patty shells.

Note that the portion cost and selling price used in Figure 9 is for the Seafood Newburg alone (a true à la carte price) and not the cost of all accompaniments found on the plate when the dish is served.

For example, the cost of bread and butter, vegetables, and even garnishes such as a wedge of lemon and a sprig of parsley must be added to the total cost to determine the appropriate selling price for the Seafood Newburg.

COSTING INDIVIDUAL ITEMS ON A PLATE

If you need to determine the total cost of a plate that has multiple components, rather than a recipe, you can follow the procedure in the example below.

Example 11

Standard order of bacon and eggs: the plate contains two eggs, three strips of bacon, toast, and hash browns.

The cost of ingredients used for accompaniment and garnish can be determined by using the standard portion cost formula, which is the purchase price of a container (often called a unit) divided by the number of portions in the container. That is,

standard portion cost = unit cost ÷ portions in the unit

An example is a carton of eggs. If eggs cost $2.00 a dozen and a standard portion in a menu breakfast item is two eggs, the standard portion cost can be found.

Recall the equation:

standard portion cost = unit cost ÷ portions in the unit

Now, find the portions in the unit.

portions in the unit = number in unit ÷ number in a portion

= 12 ÷ 2

= 6

That is, there are six 2-egg portions in a dozen eggs.

Substitute the known quantities into the equation.

standard portion cost = unit cost ÷ portions in unit

= $2.00 ÷ 6

= $0.33

You could get the same answer by calculating how much each egg in the dozen is worth ($2.00 ÷ 12 = $0.17) and then multiplying the cost per egg by the number of eggs needed ($0.17 × 2 = $0.34). No matter what method is used, the standard portion of two eggs in this order of bacon and eggs has a standard portion cost of $0.34.

You can find the standard portion cost of the bacon in the same way. If a 500 g package of bacon contains 20 rashers and costs $3.75, the standard portion cost of a portion consisting of four rashers can be found quickly:

portions in the unit = 20 ÷ 4

= 5

standard portion cost = unit cost/portions in unit

= $3.75 ÷ 5

= $0.75

The bacon and eggs on the plate would have a standard portion cost of $1.09. You could determine the cost of hash browns, toast, jam, and whatever else is on the plate in the same manner.

Often, restaurants will serve the same accompaniments with several dishes. In order to make the costing of the entire plate easier, they may assign a "plate cost," which would include the average cost of the standard starch and vegetable accompaniments. This makes the process of pricing daily specials or menu items that change frequently easier, as you only need to calculate the cost of the main dish and any specific sauces and garnishes, and then add the basic plate cost to the total to determine the total cost of the plate.

Figures 10 and 11 provide an example for calculating the basic plate cost and the cost of daily features.

Figure 10

Calculating basic plate cost for daily meat special

Mashed potatoes, one serving	$0.50
Mixed vegetables, one serving	$0.75
Demi-glace, one serving	$0.30
Herb garnish	$0.20
Total basic plate cost	$1.75

Figure 11

Calculating the cost of daily features using a basic plate cost

Day	Feature	Feature Cost per Portion	Basic Plate Cost	Total Cost
Monday	Roast beef	$5.00	+ $1.75	= $6.75
Tuesday	Pork chop	$3.75	+ $1.75	= $5.50
Wednesday	Half roast chicken	$4.00	+ $1.75	= $5.75

4.3 COOKING LOSS TEST

Some meats cannot be accurately portioned until they are cooked. This applies particularly to roasts, which shrink during cooking. The amount lost due to shrinkage can be minimized by incorporating the principles of low-temperature roasting, but some shrinkage is unavoidable.

The cooking loss test serves the same function as the meat cutting yield test. Their similarities and differences will become evident in the discussion below. Figure 13 shows a sample cooking loss test form.

Figure 13: Cooking Loss Test Form

Item: Leg of Lamb

Portion: 125 g

Cost factor: 0.2931

Number cooked: One

Time: 2 hours and 30 minutes

Temperature: 175°C

Breakdown	Weight	% of Total Weight	Value (per kg)	Total Value	EP Cost (per kg)	Portion Size	Portion Cost	Cost Factor (per kg)	Cost factor per portion
Original weight	3750 g	100%	$6.50	$24.38					
Trimmed weight	2850 g	76.00%		$24.38					
Loss in Trimming	900 g	24%		0					
Cooked Weight	2350 g	62.67%		$24.38					
Loss in Cooking	500 g	13.33%		0					
Bones and Trim	750 g	20%		0					
Saleable Weight	1600 g	43.00%		$24.38	$15.24	125 g	$1.91	2.3446	0.2931

When using a cooking loss test form, note the following, referring to Figure 13:

- The form specifies the time and temperature of the roasting.

- The column headings are similar to the column headings on the meat cutting yield test form (Figure 12), as you are measuring similar things.
- The first line in Figure 13 lists the weight and wholesale cost of the roast (total value).
- The trimmed weight is the weight of the roast that is placed in the oven. Some fat and gristle has been trimmed off in the kitchen. In the example, about 900 g have been trimmed. Technically, if the trim has some value, it should be used to reduce the total value of the roast. However, for simplicity it is ignored in this example.
- After cooking for 2 hours and 30 minutes (the time stated on the test form), the roast is weighed and the cooked weight is entered on the form.
- The weight loss in cooking is determined by subtracting and the value entered on the form.
- The cooked roast is then deboned and trimmed. The weight of this waste is recorded.
- The weight of the remaining roast is determined. This is the amount of cooked roast you have available to sell and which can be divided into portions.
- Notice that the total value (that is, the cost) of the roast remains the same throughout the process. Only the weight of the roast changes.
- The percentage of total weight figures are calculated in the same way they were determined in Figure 12.
- The cost of usable kg is determined by dividing the saleable weight into the total value of the roast.
- Portion size is determined by restaurant managers, and the portion cost is calculated by multiplying the cost of usable kg and the portion size. This is the same procedure used to determine portion cost on the meat cutting yield test form.
- The cost factor per kg is the ratio of the cost of usable kg and the original value per kg.

Example 22: Equation

cost factor per kg = cost of usable kg ÷ value per kg

= $15.24 ÷ $6.50

= 2.3446

- The cost factor per portion is again found by multiplying the cost factor per kg by the portion size.

As with the meat cutting yield test, the most important entries on the cooking loss test sheet are the portion cost and the cost factor per kg as they can be used to directly determine the portion and kilogram costs if the wholesale cost unit price changes.

Yield percentages are the ratio to total weight values found for usable meat on the meat cutting yield test sheet and the saleable weight found on the cooking loss test. Once found, yield percentages (or yield factors as they are sometimes called) are used in quantity calculations.

The general relationship between quantity and yield percentage can be seen in the following equation:

quantity needed = (number of portions × portion size) ÷ yield percentage

Example 23: Equation

Find the quantity of pork loin needed to serve 50 people 250-g portions if the yield percentage is 52% as in Figure 12. The solution is:

quantity needed = (number of portions × portion size) ÷ yield percentage

= (50 × 0.250 kg) ÷ 52%

= 12.5 kg ÷ 0.52

= 24.03 kg

You need just over 24 kg of untrimmed pork loin to serve 50 portions of 250 g each.

The yield formula can be restated in other ways. For example, if you needed to find how many 125 g portions of lamb can be served from 12 kg of uncooked lamb given a yield factor of 43%, you could use the following procedure:

Example 24: Equation

number of portions = (quantity on hand × yield percentage) ÷ portion size

= (12 kg × 0.43) ÷ 0.125 kg

= 5.16 kg ÷ 0.125

= 41.28

As with the inventory sheets, using a spreadsheet to help calculate the yields and factors is helpful. Some sample tools are provided in the Appendix.

4.2 YIELD TESTING

Yield in culinary terms refers to how much you will have of a finished or processed product. Professional recipes should always state a yield; for example, a tomato soup recipe may yield 15 L, and a muffin recipe may yield 24 muffins. Yield can also refer to the amount of usable product after it has been processed (peeled, cooked, butchered, etc.)

For example, you may be preparing a recipe for carrot soup. The recipe requires 1 kg of carrots, which you purchase. However, once you have peeled them and removed the tops and tips, you may only have 800 grams of carrots left to use.

In order to do accurate costing, yield testing must be carried out on all ingredients and recipes. When looking at yields, you must always consider the losses and waste involved in preparation and cooking. There is always a dollar value that is attached to vegetable peel, meat and fish trim, and packaging like brines and syrups. Any waste or loss has been paid for and is still money that has been spent. This cost must always be included in the menu price.

> **Note:** Sometimes, this "waste" can be used as a by-product. Bones from meat and fish can be turned into stocks. Trimmings from vegetables can be added to those stocks or, if there is enough, made into soup.

All products must be measured and yield tested before costing a menu. Ideally, every item on a menu should be yield tested before being processed. Most big establishments will have this information on file, and there are many books that can also be used as reference for yields, such as The Book of Yields: Accuracy in Food Costing and Purchasing.

Example 12: The procedure for testing yields

1. Record the original weight/volume of your item. This is your raw weight or **as purchased (AP) weight**.
    1. Whole tenderloin – 2.5 kg
    2. Whole sockeye salmon – 7.75 kg
    3. Canned tuna flakes in brine – 750 mL
2. Process your product accordingly, measure and record the waste or trim weight.

1. Tenderloin fat, sinew, chain, etc. – 750 g tenderloin trim
2. Salmon head, bones, skin, etc. – 2.75 kg salmon trim
3. Brine – 300 mL canned tuna waste

3. Subtract the amount of trim weight from the AP weight and you will have what is referred to as your processed or **edible product (EP) weight**. The formula is: AP weight – waste = EP weight.
   1. 2500 g – 750 g = 1750 g processed tenderloin
   2. 7750 g – 2750 g = 5000 g processed salmon
   3. 750 mL – 300 mL = 400 mL processed canned tuna
4. Get your yield percentage by converting the edible product weight into a percentage. The formula is EP weight ÷ AP weight × 100 = yield %.
   1. (1750 ÷ 2500) × 100 = 70% for the tenderloin
   2. (5000 ÷ 7750) × 100 = 64.51% for the salmon
   3. (400 ÷ 750) × 100 = 53.33% for the canned tuna

Yield percentage is important because it tells you several things: how much usable product you will have after processing; how much raw product to actually order; and the actual cost of the product per dollar spent.

USING YIELD TO CALCULATE FOOD COSTS

Once you have your yield percentage, you can translate this information into monetary units. Considering the losses incurred from trimmings and waste, your actual cost for your processed ingredient has gone up from what you originally paid, which was your raw cost or AP cost. These calculations will provide you with your processed cost or EP cost.

Example 13: The procedure for determining EP cost

1. Record the AP cost, what you paid for the item:
   1. Whole tenderloin – \$23.00/kg
   2. Whole sockeye salmon – \$5.00/kg
   3. Canned tuna flakes in brine – \$5.50/750 mL can
2. Obtain your factor. This factor converts all your calculations into percentages. The formula is:
   1. 100 ÷ yield % = factor
   2. 100 ÷ 70 tenderloin = 1.42

3. 100 ÷ 64.51 salmon = 1.55
4. 100 ÷ 53.33 canned tuna = 1.875

3. Once the factor has been determined, it is now an easy process to determine your EP cost. The formula is: factor × as purchased cost per (unit) = edible product cost per (unit)

    1. Tenderloin $23.00 × 1.42 = $32.66/kg
    2. Salmon $5.00 × 1.55 = $7.75/kg
    3. Canned tuna $5.50 × 1.875 = $10.78/750 mL

There could be a considerable difference in costs between the raw product and the processed product, which is why it is important to go through all these steps. Once the EP cost is determined, the menu price can be set.

YIELD TESTS AND PERCENTAGES

Meat and seafood products tend to be the most expensive part of the menu. They also have significant amounts of waste, which must be accounted for when determining standard portion cost.

When meat is delivered, unless it has been purchased precut, it must be trimmed and cut into portions. The losses due to trimming and cutting must be accounted for in the portion cost of the meat. For example, if a 5 kg roast costing $8 a kilogram (total cost is $40) is trimmed of fat and sinew and then weighs 4 kg, the cost of usable meat (the EP cost), basically, has risen from $8 a kilogram to $10 a kilogram ($40 ÷ 4 kg). The actual determination of portion cost is found by conducting a meat cutting yield test.

The test is conducted by the person who breaks down or trims the wholesale cut while keeping track of the weight of the parts. The information is placed in columns on a chart, as shown in Figure 12. The column names and their functions are discussed below.

Figure 12: Meat Cutting Yield Test

Item: Pork Loin – Grade A-1

Date:

Meat cutting yield test

Part of the meat	Weight	% of total	Value per kg	Total value	Cost factor	EP cost (per kg)	Portion size	Portion cost
Whole piece (AP)	2.5 kg		$12.14	$30.35				
Fat and gristle	850 g	34%	$0.20	$0.17				
Loss in cutting	100 g	4%	0					
Trim	250 g	10%	$7.49	$1.87				
Usable meat	1300 g	52%		$28.31	1.79	$21.78	250 g	$5.45

The parts of the meat are listed on the yield test sheet under the heading "Breakdown." In the example in Figure 12, a pork loin has been broken down into fat and gristle, loss in cutting, trim, and usable meat. Various measures and calculations are then recorded in the different columns:

- Weight: Next to the breakdown column the weights of the individual parts are listed.
- Percentage of total weight: The third column contains the percentage of the original piece by weight. The column is headed "% of total weight," which reminds us how to calculate the percentages. That is,

% of total weight = weight of part ÷ total weight

For example, in Figure 12, the fat and gristle weighs 850 g (or 0.850 kg). The total weight of the pork loin before trimming is 2.5 kg.

Example 14: Percentage of fat and gristle equation

% of fat and gristle = weight of part ÷ total weight

= 0.850 kg ÷ 2.5 kg

= 0.34

= 34%

Using the same procedure, you can calculate:

% of loss in cutting = 0.100 kg ÷ 2.5 kg

= 0.04

= 4%

% of trim = 0.250 kg ÷ 2.5 kg

= 0.1

= 10%

% of usable meat = 1.300 kg ÷ 2.5 kg

= 0.52

= 52%

Note: The percentage of usable meat is an important concept. It is often referred to as the *yield percentage* or *yield factor*. It will be looked at in some detail later in this chapter.

- Value per kg: This column of Figure 12 lists the value of the parts per unit of weight. These values are based on what it would cost to purchase similar products from a butcher shop. The tidbits are quite valuable although they are too small to be used as medallions. They might be used, however, in stews or soups. Notice that no value is given to any weight lost in cutting.
- Total value: This is determined by multiplying the value per kg column by the weight column. This has to be done carefully as the units must match. For example, the temptation is to simply multiply the weight of the fat and gristle (850 g) by $0.20 and get $170 instead of converting the grams into kilograms (850 g = 0.850 kg) and then multiplying to give the actual value of $0.17.

The entry for the "Usable Meat" in the total value column is determined by subtracting the value of the breakdown parts from the total cost of the pork loin ($30.35). The total cost is found by multiplying the weight of the whole piece (2.5 kg) by the value per kg ($12.14).

Example 15: The total value of usable meat equation

total value of usable meat = total cost – total value of breakdown parts

= $30.35 – ($0.17 + $1.87)

= $30.35 – (2.04)

= $28.31

- Cost of usable kg (or EP cost): cost of usable kilogram is determined by dividing the total value of the usable meat by the weight of the usable meat as measured in kilograms (see below).

Example 16: Cost of usable kg (or EP cost) equation

cost per usable kg = total value of usable meat ÷ kg weight of usable meat

= \$28.31 ÷ 1.3 kg (remember 1300 g = 1.3 kg)

= \$21.78

Notice the difference between the wholesale cost (\$12.14 kg) and the cost of usable meat (\$21.78). This difference shows why the basic formula for determining standard portion costs will not work with meat.

- Portion size and portion cost: The last two columns in Figure 12 show portion size and portion cost. Portion size is determined by management; in this example, individual portions of the pork loin weigh 250 g (or 0.250 kg).

Example 17: The portion cost is determined by multiplying the cost of a usable kg by the portion size.

That is,

portion cost = portion size × cost of usable kg

Using the correct units is very important. The portion size should be converted into kilograms as the cost per usable kg has been found.

Example 18: Portion size equation

portion cost = portion size × cost of usable kg

= 0.250 kg × \$21.78/kg

= \$5.44

- Cost factor: If the price of pork loin changes, the monetary values entered on the meat cutting yield sheet become invalid. This column in Figure 12 attempts to reduce the chance that all this work is suddenly for naught. The cost factor will probably not change drastically but the wholesale cost of purchasing the meat might. By having a cost factor on hand, you can quickly apply it to the wholesale price of the purchased product and determine what an appropriate selling price should be. The cost factor per kilogram is determined by dividing the cost per usable kg by the original cost per kilogram (see below).

Example 19: Cost factor equation

cost factor per kg = cost per usable kg ÷ original cost per kg

In this example,

cost factor per kg = cost per usable kg ÷ original cost per kg

= \$21.78 ÷ \$12.14

= 1.79

This cost factor can be used to find the cost of a usable kg if the wholesale cost changes with the following formula.

Example 20: Finding the cost of usable kg if wholesale cost changes

new cost of usable kg = cost factor per kg × new wholesale cost

For example, if the cost of pork loin should rise to \$13.00 a kilogram from the \$12.14 per kilogram given on the cutting yield test sheet, the new cost per usable kg can be quickly calculated:

new cost of usable kg = cost factor per kg × new wholesale cost

= 1.79 × \$13.00

= \$23.27

Notice the size of the increase is in usable kg cost. The wholesale cost rose by (\$13.00 – \$12.14) \$0.86 a kg, but the new cost of usable meat rose by \$1.49 a kg.

Example 21: Cost factor per portion equation

The cost factor per portion is found by multiplying the portion size by the cost factor per kilogram. In this example,

cost factor per portion = portion size × cost factor per kg

= 0.250 kg × 1.79

= 0.45

The cost factor per portion is important because it can be used to find the cost per portion from the wholesale cost of meat. This is done by multiplying the two quantities. For example, if the wholesale price of pork loin should rise to $13.00 a kg, the portion cost will become:

new portion cost = cost factor per portion × new wholesale cost

= 0.45 × $13.00

= $5.85

The cost factor per kilogram and the cost factor per portion are the most important entries on a meat cutting yield test as they can be used to adjust to changing wholesale costs.

Today, the meat cutting yield test is losing some of its popularity because of the introduction of pre-portioned meats. But there remain several benefits to performing meat cutting tests:

- Exact costs are determined so menu pricing can be more accurate.
- Tests done periodically verify that the meat wholesaler is providing meat to stipulated specifications. If the amount of trim and waste rises, so do food costs.
- By comparing the results from two or more wholesalers who have provided the same sample cuts, a critical evaluation can be done to determine which one is supplying the better meat.
- Comparing yields between people doing the cutting will tell you who is being the most efficient.
- Since individual pieces of meat or fish may vary slightly, doing yield tests on several of the same item and taking an average will give you the best idea of your standard yield.

APPENDIX: SAMPLE KITCHEN MANAGEMENT TOOLS SPREADSHEET

Sample-Kitchen-Management-Tools [Excel file]

This Excel workbook has a number of sample tools and calculators that you can use to build your own customized spreadsheets and tools for kitchen management. Included are:

- Yield Test Calculator
- Recipe Cost Calculator
- Inventory Spreadsheet
- Ordering Spreadsheet
- Cooking Loss Spreadsheet

GLOSSARY

as purchased (AP) weight
The gross weight.

average cover
The average amount spent by a customer in a meal period or month.

baker's percentage
A formula that states the ingredients in relation to the amount of flour.

breakeven point
The point at which cost and revenue are equal.

capital
Physical assets or money used in the production of goods and services.

closing inventory
The amount of product on hand at the end of the inventory period.

contribution margin
Portion of sales that can be applied against fixed costs; gross sales minus variable costs.

count
1. Number of items in stock
2. Number of items in a case or to the pound or kilogram

directs
Products purchased and used as soon as they arrive or on the same day.

edible product (EP) weight
The amount of usable product after cleaning or portioning.

extending
Calculating the total value of goods on hand after taking a physical inventory.

FIFO
First in, first out; a system of managing inventory so that the product received first gets used first.

fixed cost
Costs which do not change based on the volume of business.

food cost
: The direct cost of food.

inventory
: Total goods in stock at any one time.

invoice
: A document indicating the amount owed for goods or services.

labour cost
: The cost of labour required for a fixed period of time; usually reflected as a percentage of sales

menu engineering
: 1. To maximize profitability by encouraging customers to buy what you want them to buy
2. Structuring of a menu to balance low- and high-profit items to achieve overall target food costs and profit

opening inventory
: The amount of product on hand at the start of the inventory period.

overhead
: The ongoing expenses required to operate a business that are not direct costs of producing goods or services.

par stock
: Maximum amount of an item that should be in stock at any one time.

perpetual inventory
: A system of tracking product as it is received and used, thereby keeping a running total of items on hand

physical inventory
: A physical inventory requires that all items in storage be counted periodically.

point-of-sale (POS) system
: A computerized system that coordinates customer purchases, sales, and costs through various linked terminals in a business.

portion cost
: The cost of a single portion.

productivity
: A measure of the amount of work done in a fixed period.

profit
: Any revenue left over after all costs have been covered.

profitability
The amount of profit a business generates compared to sales, usually reflected in a percentage.

purchase order
A document indicating the approval of a quantity of goods ordered from a supplier.

ratio
The proportion between two amounts, usually with one item being referred to as 1.

receiver
The individual responsible for accepting and checking deliveries.

rotate
To rearrange inventory so that the oldest product is placed in front of newly acquired product.

sales
Total revenue received for goods or services in a fixed period.

specific gravity
The density of a substance (mass for a given volume), when compared against a reference substance, such as water.

specifications
Purchase criteria such as size, grade, packaging, market form.

standardized recipe
Consistent, tested recipe that is used by everyone in the kitchen to prepare the same product.

stores
Goods taken from the storage area and used.

turnover
1. Number of times in a period that inventory is turned into revenue.
2. Number of times in a day that a seat is filled.

volume
1. Quantity of product or business.
2. A type of measurement that measures the space taken up by a substance.

yield
Amount of usable product.

yield test
A test to determine the net or edible product (EP) weight from the gross or as purchased (AP) weight.

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This series of Open Textbooks has been developed collaboratively on behalf of the BC Provincial Cook Articulation Committee and go2HR. The committee would like to thank the following individuals for their contributions to developing, editing, and reviewing these texts:

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VERSIONING HISTORY

NSCC EDITION

Applied Math for Food Service was created by remixing content from two open textbooks published by BC Campus under CC BY licences:

- Basic Kitchen & Food Service Management by The BC Cook Articulation Committee
- Math for Trades by Chad Flinn and Mark Overgaard

The version mapping table outlines the sources for the new open textbook.

NSCC Version	Basic Kitchen & Food Service Management	Math for Trades
Chapter 1- The Metric System	2. Units of Measurement 3. Temperature 4. Converting Within the Metric System	
Math Foundation: Whole Numbers		Chapter 2- Whole Numbers 1. The Place Value System 2. Adding Whole Numbers 3. Subtracting Whole Numbers 4. Multiplying Whole Numbers 5. Dividing Whole Numbers
Chapter 2- Imperial & U.S Systems	5. Imperial & U.S. Systems of Measurement	
Math Foundation: Fractions		Chapter 3- Fractions 7. The Basics of Fractions 8. Adding and Subtracting Fractions 9. Multiplying Fractions 10. Dividing Fractions
Chapter 3- Recipes & Formulas: Converting & Scaling	6. Converting and Adjusting Recipes & Formulas	
Math Foundation: Decimals		Chapter 4- Decimals 12. Understanding Decimal Notation
Chapter 4- Yield: Factors, Percentages & Costing	11. Controlling Food Costs 12. Yield Testing 13. Cooking Loss Test	
Math Foundation: Percentages		Chapter 5- Percentages 17. What is a Percent Anyway? 18. Ratios and How They Relate to Percentage
Appendix: Sample Kitchen Management Tools	Appendix: Sample Kitchen Management Tools	
Glossary	Glossary	

BASIC KITCHEN & FOOD SERVICE MANAGEMENT VERSION NOTES

The files posted by this book always reflect the most recent version. If you find an error in this book, please fill out the Report an Open Textbook Error form.

Version	Date	Change	Details
1.00	September 4, 2015	Added to the B.C. Open Textbook Collection.	
1.01	September 27, 2018	The following changes were part of a project to standardize BCcampus-published books.	• Added an Accessibility Statement • Added additional publication information • Updated copyright information • Renamed "About the book" to "About BCcampus Open Education" and updated the content • Added a Versioning History page • Updated the book cover
1.02	June 4, 2019	Updated the book's theme.	The styles of this book have been updated, which may affect the page numbers of the PDF and print copy.
2.00	June 24, 2019	Accessibility remediation.	• Remediated the textbook to make it accessible. This involved ◦ edited link text to be descriptive ◦ changed heading levels ◦ added image descriptions ◦ edited table markup ◦ replaced images with tables ◦ applied correct math symbols • Updated the accessibility statement
2.01	September 29, 2020	Error correction.	In The Principles of Menu Engineering chapter in Figure 24, the column labels "Total Food Costs" and "Total Food Sales" needed to be swapped. Also, styling of table captions and headings was improved.
2.02	October 16, 2020	Error corrections.	In Purchasing, the heading "Production Control Chart" was corrected to "Portion Control Chart." Chapter 11 title "Standardized Purchase Specifications" was changed to "Controlling Food Costs."