Introduction to Units and Conversions

The metric system originates back to the 1700s in France. It is known as a decimal system because conversions between units are based on powers of ten. This is quite different to the Imperial system of units where every conversion has a unique value.

A physical quantity is an attribute or property of a substance that can be expressed in a mathematical equation. A quantity, for example the amount of mass of a substance, is made up of a value and a unit. If a person has a mass of 72kg: the quantity being measured is Mass, the value of the measurement is 72 and the unit of measure is kilograms (kg). Another quantity is length (distance), for example the length of a piece of timber is 3.15m: the quantity being measured is length, the value of the measurement is 3.15 and the unit of measure is metres (m).

A unit of measurement refers to a particular physical quantity. A metre describes length, a kilogram describes mass, a second describes time etc. A unit is defined and adopted by convention, in other words, everyone agrees that the unit will be a particular quantity.

Historically, the metre was defined by the French Academy of Sciences as the length between two marks on a platinum-iridium bar at 0°C, which was designed to represent one ten-millionth of the distance from the Equator to the North Pole through Paris. In 1983, the metre was redefined as the distance travelled by light in free space in $\frac{1}{299\,792\,458}$ of a second.

The kilogram was originally defined as the mass of 1 litre (known as 1 cubic decimetre at the time) of water at 0°C. Now it is equal to the mass of international prototype kilogram made from platinum-iridium and stored in an environmentally monitored safe located in the basement of the International Bureau of Weights and Measures building in Sèvres on the outskirts of Paris.

The term SI is from “le Système international d'unités”, the International System of Units. There are 7 SI base quantities. It is the world's most widely used system of measurement, both in everyday commerce and in science. The system is nearly universally employed.

SI Base Units		
Base quantity	Name	Symbol
Length	metre	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Thermodynamic temperature	kelvin	K
Amount of substance	mole	mol
Luminous intensity	candela	cd

For other quantities, units are defined from the SI base units. Examples are given below.

SI derived units (selected examples)

Quantity	Name	Symbol
Area	square metre	m^2
Volume	cubic metre	m^3
Speed	metre per second	m / s
Acceleration	metre per second squared	$m / \sec^2$

Some SI derived units have special names with SI base unit equivalents.

SI derived units (selected examples)			
Quantity	Name	Symbol	SI base unit equivalent
Force	Newton	N	$m\,kg / \sec^2$
Pressure	Pascal	Pa	N / m^2
Work, Energy	Joule	J	$N\,m$
Power	Watt	W	J / s
Electric Charge	Coulomb	C	$A\,s$
Electric Potential Difference	Volt	V	W / A
Celsius (temperature)	degree Celsius	°C	K
Frequency	Hertz	Hz	$/ s$
Capacity	litre	L (or l)	dm^3

If units are named after a person, then a capital letter is used for the first letter. Often, litres is written with a capital (L) because a lowercase (l) looks like a one(1).

An important feature of the metric system is the use of prefixes to express larger and smaller values of a quantity. For example, a large number of grams can be expressed in kilograms, and a fraction of a gram could be expressed in milligrams.

Commonly used prefixes are listed in the table below.

		Multiplication Factor		
Name	Symbol	Word form	Standard form	Power of 10
peta	P	Quadrillion	1 000 000 000 000 000	10^{15}
tera	T	Trillion	1 000 000 000 000	10^{12}
giga	G	Billion	1 000 000 000	10^{9}
mega	M	Million	1 000 000	10^{6}
kilo	k	Thousand	1 000	10^{3}
hecto	h	Hundred	100	10^{2}
deca	da	Ten	10	10^{1}
deci	d	Tenth	0.1	10^{-1}
centi	c	Hundredth	0.01	10^{-2}
milli	m	Thousandth	0.001	10^{-3}
micro	μ, mc	Millionth	0.000 001	10^{-6}
nano	n	Billionth	0.000 000 001	10^{-9}
pico	p	Trillionth	0.000 000 000 001	10^{-12}

The use of prefixes containing multiples of 3 are the most commonly used prefixes.

Using prefixes, conversions between units can be devised.

For example:

1kg = 1000g	On the left hand side the prefix is used. On the right hand side the prefix is replaced with the multiplication factor.
1mg = 0.001g	On the left hand side the prefix is used. On the right hand side the prefix is replaced with the multiplication factor. To make the conversion friendlier to use, multiply both sides by 1000 (Why 1000? Because milli means one thousandth and one thousand thousandths make one whole), so 1000mg = 1g.
1Mm = 1 000 000m	On the left hand side the prefix is used. On the right hand side the prefix is replaced with the multiplication factor.
1 μm = 0.000 001m	On the left hand side the prefix is used. On the right hand side the prefix is replaced with the multiplication factor. To make the conversion friendlier to use, multiply both sides by 1 000 000 (Why 1 000 000? Because micro means one millionth), so 1 000 000 μm = 1 m

Video ‘Obtaining Conversions from Prefixes’

Numeracy

Module contents

Introduction

- **Conversions – traditional method**
- **Conversions – dimensional analysis method**
- **Time**

Answers to activity questions

Outcomes

- To understand the necessity for units.
- To understand the metric system and the prefixes used.
- To convert units accurately using one of the methods covered.
- To change decimal time into seconds, minutes as appropriate.
- To perform operations with time.

Check your skills

This module covers the following concepts, if you can successfully answer these questions, you do not need to do this module. Check your answers from the answer section at the end of the module.

1. What are the SI units for length, mass and time?
   What is difference between the prefix m and M?
   What is the difference between volume and capacity?

2. Using the traditional method of unit conversions, perform the following:
   (a) 495mm to m (b) 1.395kg to g (c) 58g to kg
   (d) 0.06km to mm (e) 25 000m^2 to ha (f) 3.5m^3 to L

3. Using the dimensional analysis method of unit conversions, perform the following:
   (a) 495mm to m (b) 1.395kg to g (c) 58g to kg
   (d) 0.06km to mm (e) 25 000m^2 to ha (f) 3.5m^3 to L

4. (a) What is 1440 in am/pm time?
   (b) If I leave at 2.47pm and travel for one and three quarter hours, what time do I arrive?
   (c) Change 3.15hours into hours and minutes.

Topic 1: Conversions – traditional method

<u>The base metric unit for mass is the gram</u>. Mass is the correct term for what is commonly called weight. On Earth, there is no difference in the value of mass and weight.

Unit conversions for mass units are in the table below.

Conversions based on prefixes	Conversions derived from those in the left column	
$1000\,000\mu g = 1g$	$1000\mu g = 1mg$	In nursing, *microg* is used to represent micrograms.
$1000mg = 1g$	$1000mg = 1g$	
$1000g = 1kg$	$1000g = 1kg$	
$1000\,000g = 1Mg$	$1000kg = 1Mg = 1t$	A megagram is commonly called a tonne (t)

Let's consider the example, change 4500g to kg.

When changing from a smaller unit (g) to a larger unit (kg), a smaller value will be the result. The conversion involves grams and kilograms, so the conversion required is 1000g = 1kg.
Look at this conversion, it is written with given units (grams) on the left and the new units (kilograms) on the right.

Given units on the left

New units on the right

$$1000g = 1kg$$

The conversion went from 1000 on the left to 1 on the right. To go from 1000 to 1, dividing by 1000 is required. In this question, dividing by 1000 must also take place. 4500 divided by 1000 requires the moving of the decimal point by three places in a direction to make the number smaller, so the answer is 4.5

$$4500g \div 1000 = 4.5kg$$

When all the conversions are considered, they can be summarised in the table below.

$$\text{microgram} \underset{\div 1000}{\overset{\times 1000}{\rightleftarrows}} \text{milligram} \underset{\div 1000}{\overset{\times 1000}{\rightleftarrows}} \text{gram} \underset{\div 1000}{\overset{\times 1000}{\rightleftarrows}} \text{kilogram} \underset{\div 1000}{\overset{\times 1000}{\rightleftarrows}} \text{megagram (tonne)}$$

Change 3.25t to kg.

When changing from a larger unit (g) to a smaller unit (kg), a larger value will be the result. The conversion involves tonnes and kilograms, so the conversion required is $1000kg = 1t$.

Look at this conversion, is it written with existing units (tonnes) on the left and new units (kilograms) on the right? The answer to this is ‘no’ so change the order of the equation to be:

$$1t = 1000kg \ .$$

The conversion went from 1 on the left to 1000 on the right. To go from 1 to 1000 multiplying by 1000 is required. In the question, multiplying by 1000 must also take place. 3.25 multiplied by 1000 requires the moving of the decimal point by three places in a direction to make the number larger, so the answer is 3 250

$$3.25t \times 1000 = 3250kg$$

Change 1.42kg to mg.

There is no conversion to change from kg to mg. To achieve this, two conversions are required, they are, kg to g and then g to mg.

1.42 kg to gram uses the conversion $1000g = 1kg$ which has to be changed to $1kg = 1000g$. To change from kg to grams, multiplying by 1000 is required.

$$1.42kg \times 1000 = 1420g$$

Changing 1420g to mg uses the conversion $1000mg = 1g$ which has to be changed to $1g = 1000mg$. To change from g to mg, multiplying by 1000 is required. $1420g \times 1000 = 1420\,000mg$;

$$\text{overall } 1.42kg = 1420\,000mg \ .$$

$$\begin{tikzcd}
\text{microgram} \arrow[r, bend right, "\div 1000"'] & \text{milligram} \arrow[l, bend right, "\text{x } 1000"'] \arrow[r, bend right, "\div 1000"'] & \text{gram} \arrow[l, bend right, "\text{x } 1000"'] \arrow[r, bend right, "\div 1000"'] & \text{kilogram} \arrow[l, bend right, "\text{x } 1000"'] \arrow[r, bend right, "\div 1000"'] & \text{megagram (tonne)} \arrow[l, bend right, "\text{x } 1000"']
\end{tikzcd}$$

Change 455 μgrams (micrograms) to mg.

Using the table above, the conversion from micrograms to milligrams requires dividing by 1000.

$$455\mu g \div 1000 = 0.455mg$$

Change 1.2g to mg.

Using the table above, the conversion from grams to milligrams requires multiplying by 1000.

$$1.2g \times 1000 = 1200mg$$

<u>The base metric unit for length is the metre</u>. Length is the same as distance. For most quantities, conversions are usually based on 1000. Length is similar but the unit **centimetre** is included. Centimetres are used because everyday measurements in centimetres are in the familiar number region 1- 100.

Unit conversions for length units are in the table below.

Conversions based on prefixes	Conversions derived from those in the left column	
$1000\,000\mu m = 1m$	$1000\mu m = 1mm$	Microscope measurements use micrometres (or microns). Red blood cells are about 8 microns in diameter, a human hair about 100 microns.
$1000mm = 1m$	$1000mm = 1m$	
$100cm = 1m$	$10mm = 1cm$	
	$100cm = 1m$	It is very unusual to use a centi-unit.
$1000m = 1km$	$1000m = 1km$	
$1000\,000m = 1Mm$	$1000km = 1Mm$	The unit megametres is not generally used in everyday use.

Let's consider the example, change 7900m to km.

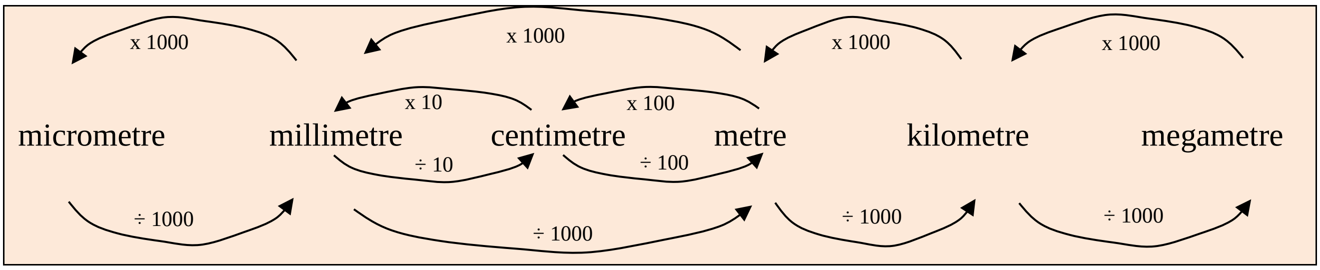
When changing from a smaller unit (g) to a larger unit (kg), a smaller value will be the result. The conversion involves metres and kilometres, so the conversion required is $1000m = 1km$.

Look at this conversion, is it written with existing units (metres) on the left and new units (kilometres) on the right? The answer to this is 'yes' so no changing of the conversion is required.

The conversion went from 1000 on the left to 1 on the right. To go from 1000 to 1 dividing by 1000 took place. In the question, dividing by 1000 must also take place. 7900 divided by 1000 requires the moving of the decimal point by three places in a direction to make the number smaller, so the answer is 7.9

$$7900m \div 1000 = 7.9km$$

When all the conversions are considered, they can be summarised in the table below.



Change 0.532km to cm

There is no conversion to change from km to cm. To achieve this, two conversions are required, they are, km to m and then m to cm.

0.532 km to metres uses the conversion multiplying by 1000. (Based on the table above)

$$0.532km \times 1000 = 532m$$

Changing 532m to cm uses the conversion multiplying by 100.(Based on the conversion above)

$$532m \times 100 = 53\,200cm,$$
$$\text{overall } 0.532km = 53\,200cm.$$

<u>The base metric unit for capacity is Litres</u>. Capacity is how much a container can hold or is holding with particular reference to fluid. Closely related to this is the concept of volume which is the amount of space within a container.

Unit conversions for capacity units are in the table below.

Conversions based on prefixes	Conversions derived from those in the left column	
$1000mL = 1L$	$1000mL = 1L$	
$1000L = 1kL$	$1000L = 1kL$	
$1\,000\,000L = 1ML$	$1000kL = 1ML$	The unit Megalitre is used to describe the capacity of dams or other water storages.

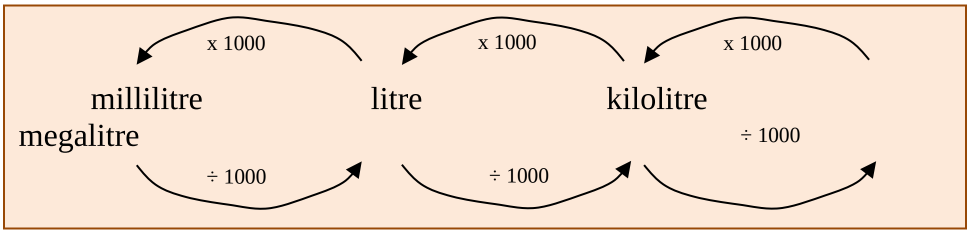
Let's consider the example, change 10350L to kL.

When changing from a smaller unit (L) to a larger unit (kL), a smaller value will be the result. The conversion involves metres and kilometres, so the conversion required is $1000L = 1kL$.

Look at this conversion, is it written with existing units (L) on the left and new units (kL) on the right? The answer to this is 'yes' so no changing of the conversion is required.

The conversion went from 1000 on the left to 1 on the right. To go from 1000 to 1 dividing by 1000 took place. In the question, dividing by 1000 must also take place. 10350 divided by 1000 requires the moving of the decimal point by three places in a direction to make the number smaller, so the answer is 10.35L

$$10350L \div 1000 = 10.35kL$$



Consider 3kL to mL

There is no conversion to change from kL to mL. To achieve this, two conversions are required, they are, kL to L and then L to kL.

3 kL to metres uses the conversion multiplying by 1000.

$$3kL \times 1000 = 3000L$$

Changing 3000L to mL uses the conversion multiplying by 1000.

$$3000L \times 1000 = 3\,000\,000mL,$$

overall $3kL = 3\,000\,000mL$.

The base unit for area is square metres m^2 . A square metre is a square with side length 1 metre. A square centimetre is a square with side length 1 centimetre. Conversions are required the change between square centimetres, square metres, hectares and square kilometres.

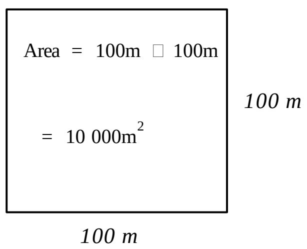
Area unit conversions can be derived from length unit conversions. Using the length conversion $100cm = 1m$, the area unit conversions can be obtained by squaring everything in the conversion;

$$(100cm = 1m)^2 = 100^2 cm^2 = 1^2 m^2 \;\rightarrow\; 10\,000\ cm^2 = 1m^2$$

Similarly, using the length conversion $1000m = 1km$, the area unit conversions can be obtained by squaring everything in the conversion;

$$(1000m = 1km)^2 = 1000^2 m^2 = 1^2 km^2 \;\rightarrow\; 1000\,000\ m^2 = 1km^2$$

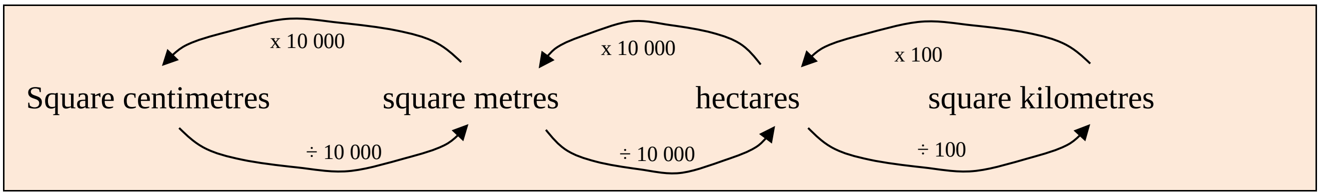
Hectares are a unit of area that is in between a square metre and a square kilometre.



A hectare is based on a square with side length 100m (hectometre).

Hectares are just hectares, they are not called square hectares, although technically a hectare is another name for a square hectometre!

Unit conversions for area units are in the diagram below.



Change $45\,000m^2$ *to ha*

The conversion involves square metres and hectares, so the conversion required is $10\,000m^2 = 1ha$

Look at this conversion, is it written with existing units (square metres) on the left and new units (ha) on the right? The answer to this is ‘yes’ so no changing of the conversion is required.
The conversion went from 10 000 on the left to 1 on the right. To go from 10 000 to 1, dividing by 10 000 took place. In the question, dividing by 10 000 must also take place. 45 000 divided by 10 000 requires the moving of the decimal point by four places in a direction to make the number smaller, so the answer is 4.5 ha.

$$45\,000m^2 \div 10\,000 = 4.5ha$$

[Video ‘Obtaining Conversions involving Squares or Cubes’]

<u>The base unit for volume is cubic metres</u> m^3. A cubic metre is a cube with side length 1 metre. A cubic centimetre is a cube with side length 1 centimetre. Conversions are required the change between cubic centimetres, cubic metres, and cubic kilometres.

Volume unit conversions can be derived from length unit conversions.

Using the length conversion $100cm = 1m$, the volume units can be obtained by cubing everything in the conversion, $(100cm = 1m)^3 \rightarrow 100^3 cm^3 = 1^3 m^3 \;\rightarrow\; 1000\,000\ cm^3 = 1m^3$

Using the length conversion $1000m = 1km$, the volume units can be obtained by cubing everything in the conversion, $(1000m = 1km)^3 \rightarrow 1000^3 m^3 = 1^3 km^3 \;\rightarrow\; 1000\,000\,000\ m^3 = 1km^3$

Unit conversions for volume units are in the table below.

$$\begin{tikzcd} \text{Cubic centimetres} \arrow[r, bend right, "\div 1000\,000"'] & \text{cubic metres} \arrow[l, bend right, "\text{x } 1000\,000"'] \arrow[r, bend right, "\div 1000\,000\,000"'] & \text{cubic kilometres} \arrow[l, bend right, "\text{x } 1000\,000\,000"'] \end{tikzcd}$$

Change $3.15m^3$ *to* cm^3

The conversion involves cubic metres and cubic centimetres, so the conversion required is $1000\,000cm^3 = 1m^3$ which can also written as $1m^3 = 1000\,000cm^3$

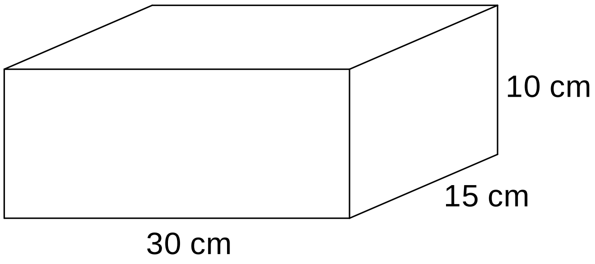
$$3.15m^3 \times 1000\,000 = 3\,150\,000cm^3$$

Because the concepts of capacity and volume are essentially the same, their units can be related.

The capacity unit mL is equivalent to the volume unit cm^3. $\boxed{1mL = 1cm^3}$

The capacity unit kL is equivalent to the volume unit m^3. $\boxed{1kL = 1m^3}$

Example: What is the capacity of the container below:



$$\begin{aligned} \text{Volume} &= l \times w \times h \\ &= 30 \times 15 \times 10 \\ &= 4500\ cm^3 \end{aligned}$$

As $1cm^3 = 1mL$, the capacity of the shape is $4500mL$ or $4.5L$.

Video 'Unit Conversions – Traditional Method'

Activity

1. Choose a unit that would be suitable to measure
   (a) The length of the Bruxner Highway
   (b) The floor area of a house
   (c) The mass of a newly born chicken
   (d) The volume of water in a water storage dam supplying a city.
   (e) The length of wood-screws

2. Change the following length measurements to the units shown in brackets

(a)	3.6m (cm)	(b)	4500m (km)
(c)	55m (km)	(d)	0.325km (mm)
(e)	4 550 000 mm (km)	(f)	5.2 cm (km)

3. Change the following mass measurements to the units shown in brackets

(a)	8550 kg (t)	(b)	0.52g (mg)
(c)	9.1mg (mcg or μg)	(d)	1.25 g (kg)
(e)	2 905 mg (kg)	(f)	35mg (g)

4. Change the following capacity measurements to the units shown in brackets

(a)	8500mL (L)	(b)	0.451kL (L)
(c)	85.9L (kL)	(d)	1.6 ML (L)
(e)	75L (kL)	(f)	0.000 6kL (L)

5. Change the following area measurements to the units shown in brackets

(a)	25 000m^2 (ha)	(b)	0.595km^2 (m^2)
(c)	26cm^2 (m^2)	(d)	31.8ha (km^2)
(e)	450 000m^2 (ha and km^2)	(f)	575 212cm^2 (m^2)

6. Change the following volume measurements to the units shown in brackets

(a)	356 000cm^3 (m^3)	(b)	2.575 m^3 (cm^3)
(c)	0.000 4 km^3 (m^3)	(d)	375 cm^3 (m^3)

7. Change the following volume units to the capacity units shown in brackets

(a)	345 cm^3 (mL)	(b)	0.072 m^3 (L)
(c)	5.5m^3 (L)	(d)	67 500 cm^3 (kL)

Topic 2: Conversions – dimensional analysis method

This method of converting units is used in science and engineering. This method is an effective way converting units using the established conversions.

Example: 3.5m to mm.

The conversion $1m = 1000mm$ is changed into a fraction. There are two possibilities for the fraction, either $\frac{1000mm}{1m}$ or $\frac{1m}{1000mm}$. The correct choice is the fraction in which the existing unit will cancel out to leave the new unit.

The correct choice is $3.5m \times \frac{1000mm}{1m}$ because the existing unit (m) cancels out to leave the new unit mm.

$$\begin{aligned}
&3.5m \times \frac{1000mm}{1m} \\
&= 3.5\cancel{m} \times \frac{1000mm}{1\cancel{m}} \\
&= 3.5 \times 1000\ mm \\
&= 3500mm
\end{aligned}$$

Example: 3.6m to km.

The conversion $1000m = 1km$ is changed into a fraction. The fraction will be $\frac{1km}{1000m}$ so the metres will cancel out leaving just the units km.

$$\begin{aligned}
&3.6\cancel{m} \times \frac{1km}{1000\cancel{m}} \\
&= \frac{3.6}{1000} km \\
&= 0.0036km
\end{aligned}$$

Example: 40500L to kL.

The conversion $1000L = 1kL$ is changed into a fraction. The fraction well be $\frac{1kL}{1000L}$ so the litres will cancel out leaving just the units kL.

$$\begin{aligned}
&40500\cancel{L} \times \frac{1kL}{1000\cancel{L}} \\
&= \frac{40500}{1000}kL \\
&= 40.5kL
\end{aligned}$$

Example: 0.000856kg to mg.

This requires 2 conversions, $1000g = 1kg$ and $1000mg = 1g$. The conversion can be done in two stages or combined into one,

$$\begin{aligned}
&0.000856\cancel{kg} \times \frac{1000g}{1\cancel{kg}} \\
&= 0.000856 \times 1000g \\
&= 0.856g
\end{aligned}$$

then

$$\begin{aligned}
&0.856\cancel{g} \times \frac{1000mg}{1\cancel{g}} \\
&= 0.856 \times 1000mg \\
&= 856mg
\end{aligned}$$

Alternatively, combined like below:

$$\begin{aligned}
&0.000856\cancel{kg} \times \frac{1000\cancel{g}}{1\cancel{kg}} \times \frac{1000mg}{\cancel{g}} \\
&= 0.000856 \times 1000 \times 1000mg \\
&= 856g
\end{aligned}$$

Example: 975cm to km.

Using the conversions $100cm = 1m$ and $1000m = 1km$, the two conversions can be combined like below:

$$\begin{aligned}
&975\cancel{cm} \times \frac{1\cancel{m}}{100\cancel{cm}} \times \frac{1km}{1000\cancel{m}} \\
&= \frac{975}{100 \times 1000}km \\
&= 0.00975km
\end{aligned}$$

Example: 2474m^2 to ha.

Using the conversion $10\,000m^2 = 1ha$, the conversion can take place as;

$$\begin{aligned}
&2474\cancel{m^2} \times \frac{1ha}{10\,000\cancel{m^2}} \\
&= \frac{2474}{10\,000}ha \\
&= 0.2474ha
\end{aligned}$$

Rate units can also be changed using this method.

Example: 60 km/hr to m/sec.

The conversions required are $1000m = 1km$ and $3600\sec = 1hr$. It is advisable to write $60\,km/hr$ as $\frac{60km}{1hr}$

$$\begin{aligned}
&\frac{60\,\cancel{km}}{1\,\cancel{hr}} \times \frac{1000m}{1\,\cancel{km}} \times \frac{1\,\cancel{hr}}{3600\sec} \\
&= \frac{60 \times 1000}{3600}m/\sec \\
&= 16.67\,m/\sec \text{(to 2 d.p.)}
\end{aligned}$$

Example: 30 L/hr to mL/min.

The conversions required are $1000mL = 1L$ and $60\min = 1hr$.

$$\begin{aligned}
&\frac{30\,\cancel{L}}{1\,\cancel{hr}} \times \frac{1000mL}{1\,\cancel{L}} \times \frac{1\,\cancel{hr}}{60\min} \\
&= \frac{30 \times 1000}{60}mL/\min \\
&= 500\,mL/\min
\end{aligned}$$

Conversion between Imperial units and metric units can also be done this way if the conversion is known.

Example: 3.75in to cm, using the conversion $1in = 2.54cm$ (the abbreviation *in* is an abbreviation for inches)

The conversion required is $1in = 2.54cm$.

$$\begin{aligned}&3.75\cancel{in} \times \frac{2.54cm}{1\cancel{in}}\\&= 3.75 \times 2.54cm\\&= 9.525cm\end{aligned}$$

Example: 200cm^2 to in^2.

The conversion $1in = 2.54cm$ is known, however the conversion required must be obtained by squaring the conversion.

$$\begin{aligned}1^2 in^2 &= 2.54^2 cm^2\\1in^2 &= 6.4516cm^2\end{aligned}$$

The conversion is:

$$\begin{aligned}&200\cancel{cm^2} \times \frac{1in^2}{6.4516\cancel{cm^2}}\\&= \frac{200}{6.4516} in^2\\&\approx 31in^2\end{aligned}$$

The conversion below is very unusual and requires careful thinking. In the imperial system, the fuel mileage of cars was measured in miles per gallon (mpg). In the metric system, the emphasis is really on fuel consumption so the units chosen were litres per 100km (L/100km).

Example: 35mpg to L/100km

Two conversions are required here: 1mile = 1.61 km and 1 imperial gallon = 4.55 litres (there are many definitions of a gallon; we are using the imperial gallon which was used in Australia prior to changing to the metric system)

Because the new rate is volume of fuel per distance, let's think of 35mpg as being it takes 1 gallon to cover a distance of 35 miles.

$$\begin{aligned}&\frac{1\cancel{gallon}}{35\cancel{miles}} \times \frac{4.55litres}{1\cancel{gallon}} \times \frac{1\cancel{mile}}{1.61km}\\&= 4.55 \div (35 \times 1.61) litre/km\\&= 0.08075 litre/km\end{aligned}$$

To make the unit user friendly, the answer is multiplied by 100 so the figure is per 100km.

$$\begin{aligned}&0.08075 litres/km\\&= 8.075 litres/100km\end{aligned}$$

[Video 'Unit Conversions – Dimensional Analysis Method']

Activity

1. Change the following measurements using the dimensional analysis method to the units shown in brackets

(a)	3.55m (cm)	(b)	6510g (kg)
(c)	55cm (m)	(d)	1.36 kg (mg)
(e)	4 550 mm^2 (cm^2)	(f)	5.2 L (mL)
(g)	11.4 mg (g)	(h)	305 000cm^3 (m^3)
(i)	8 550 g (t)	(j)	240 000m^2 (ha)
(k)	9.352L (mL)	(l)	21.8ha (m^2)
(m)	2 905 µg (g)	(n)	15 305mg (kg)

2. Change the following metric rates to the rate shown in brackets

(a)	850mL/hr (L/hr)	(b)	4.51L/min (L/hr)
(c)	85.9km/hr (m/min)	(d)	1.6 m^2/hr (cm^2/sec)
(e)	75 mg/min (g/hr)	(f)	0.000 6 cm^3/sec (L/hr)

3. Change the following metric and imperial units to the units shown, given the conversion.
   (a) Change 25 ha to acres given that 1 hectare is 2.48 acres
   (b) Change 100 cm to inches given that 1 inch is 2.54 cm
   (c) Change 50 lbs (pounds weight) to kg given that 1 kg is 2.2 lbs
   (d) Change 100 miles to km given that 1 mile is 1.61 km
   (e) Change 36.5 oz (ounces weight) to g given that 1 oz is 28.35g
   (f) Change 100 metres to yards (yd) given that 1 m is 1.09yd
   (g) Change 308cubic inches (in^3) to cm^3 given that 1 in is 2.54 cm

4. Change the following rates to the new rate using both imperial and metric units, given the conversion.
   (a) Change 3.45 mi/hr to km/hr given that 1 mile is 1.61 km
   (b) Change 50.9 m^2/hr to yd^2/hr given that 1 m is 1.09yd
   (c) Change 6.45 gal/hr to L/min given that 1 imp. gallon is 4.55 litres
   (d) Change 3.45 ft^2/hr to cm^2/sec given that 1 ft (foot) is 30.48 cm

Topic 3: Time

Time units cause problems because conversions are not based on powers of tens, or in other words, time is not a decimal system.

Units of time include secs, min, hours, days, weeks, etc. Stopwatches will work in smaller units, usually mins, secs and hundredths of seconds (or centiseconds). A stopwatch reading of 20:31:90 means 20 minutes, 31seconds and 90 hundredths of a second. Notice that a colon (:) is used to separate the different units to avoid confusion with decimal points.

Metric prefixes can be used with seconds. The most common prefixes are milliseconds, microseconds, nanoseconds and possibly picoseconds, the prefixes having the same meaning as in the introduction material.

$$1 \text{ millisecond} = 10^{-3} \text{second}$$
$$1 \text{ microsecond} = 10^{-6} \text{second}$$
$$1 \text{ nanosecond} = 10^{-9} \text{second}$$
$$1 \text{ picosecond} = 10^{-12} \text{second}$$

The unit conversions for time are:

60 seconds = 1 minute
60 minutes = 1 hour
24 hours = 1 day
7 days = 1 week

There are other generalisations that have limited or no use as conversions for the purposes of calculations.

365 days = 1 year	In a non-leap year this is true, but a leap year is 366 days. The generalisation that a leap year is every fourth year, the year being a multiple of 4, this is not quite true, the year 2100, 2200, 2300 will not be a leap year!
52 weeks = 1 year	This is incorrect as there is 52 weeks and 1 or 2 days in a year (depending on if it is a leap year), however, this conversion is used to approximate figures.

4 weeks = 1 month	This is very incorrect as there is usually 4 weeks and 2 or 3 days in a month. If you want to convert a weekly figure to a monthly figure, it is **more** correct to multiply by 52 weeks and then divide by 12. For example: A weekly repayment of $128 is equivalent to a monthly repayment of $128 x 52 ÷ 12 = $554.67
12 months = 1year	While this is true, the length of the months is uneven, so February is 3 days shorter than January. However, monthly loan repayments are usually the same regardless of the length of the month.

Unit conversions involving time

<u>Example: Change 180 minutes to hours.</u>

The conversion to be used is 60 minutes = 1 hour.

In the traditional method, the conversion is the right way round so to go from mins to hours, dividing by 60 must occur. 180mins ÷ 60 = 3 hours	In the dimensional analysis method, $180\,\cancel{\text{mins}} \times \frac{1\text{ hour}}{60\ \cancel{\text{mins}}}$ $= \frac{180}{60}\text{hours}$ $= 3\text{ hours}$

<u>Example: Change 252 minutes to hours (and hours and mins)</u>

The conversion to be used is 60 minutes = 1 hour.

In the traditional method, the conversion is the right way round so to go from mins to hours, dividing by 60 must occur. 252 mins ÷ 60 = 4.2 hours To change this to hours and minutes, the decimal part of the hour is multiplied by 60. 0.2 x 60 = 12 252 minutes = 4.2 hours = 4 hours 12 minutes	In the dimensional analysis method, $252\,\cancel{\text{mins}} \times \frac{1\text{ hour}}{60\ \cancel{\text{mins}}}$ $= \frac{252}{60}\text{hours}$ $= 4.2\text{ hours}$ To change this to hours and minutes, the decimal part of the hour is multiplied by 60. 0.2 x 60 = 12 252 minutes = 4.2 hours = 4 hours 12 minutes

Example: Change 2 mins 41 seconds to seconds.

The conversion to be used is 60 seconds = 1 minute. Note: 2 mins 41 seconds cannot be written as 2.41 mins. As part of the question already contains seconds, only the 2 minutes needs changing to seconds. The best method is to convert 2 mins to seconds and then add on the 41 seconds. 2 mins is 2 x 60 seconds + 41 seconds gives 161 seconds.

Example: Change 2.45 hours into minutes.

Because this time is just hours, the normal conversion strategies can be used.

The conversion to be used is 60 minutes = 1 hour which is changed around to be 1 hour = 60 minutes.

In the traditional method, to go from mins to hours, multiplying by 60 must occur. 2.45 hours x 60 = 147 minutes	In the dimensional analysis method, $2.45 \text{ hours} \times \dfrac{60 \text{ mins}}{1 \text{ hour}}$ $= 2.45 \times 60 \text{ mins}$ $= 147 \text{ mins}$

Example: If a car is moving at a speed of 60km/hr, how long will it take (in hours and mins) to cover 75 km?

$$\begin{aligned} \text{speed} &= \frac{\text{distance}}{\text{time}} \\ 60\text{km/hr} &= \frac{75\text{km}}{t \text{ hrs}} \\ 60\text{km/hr} \times t \text{ hrs} &= 75\text{km} \\ t &= \frac{75\text{km}}{60\text{km/hr}} \\ t &= 1.25\text{hr} \end{aligned}$$

This means 1 hour and 0.25 of an hour. It is not 25 mins. To change this into hours and minutes,

Think
0.25 of an hour
= 0.25 of 60 minutes
= 15 minutes

The car will take 1 hour and 15 mins to cover 75 km.

Video 'Time Calculations'

24 hour time

Twenty four hour time is commonly used around the world in situations where confusion could arise due to omitting am or pm from a time. Some countries have adopted 24 hour time as the standard way to express time. The time using 24 hour time **is the elapsed time from the beginning of the day**, that is, midnight. At 7.30am, the elapsed time from the beginning of the day is 7 hours 30 mins, so in 24 hour time the time is written as 0730. It is conventional to write 24 hour time using 4 digits.

The 24 hour time at midnight is 0000 as no time has elapsed since the beginning of the day.

The 24 hour time at midday is 1200 as 12 hours has elapsed since the beginning of the day.

The 24 hour time at 3:21pm is 1521 as 15hrs and 21 minutes has elapsed since the beginning of the day.

Operations with time

The examples below demonstrate how operations involving time can occur.

Example: John travelled for 3hrs 41 mins before lunch and another 2 hours 27 mins after lunch, how long did he travel for?

This requires addition of the time periods.

	Hours	Mins
	3	41
+	2	27
	5	68

As 68 minutes exceeds 60, it can be changed to 1 hour 8 mins giving the answer

6hrs 8 mins

Example: A nurse commenced an IV at 7:58pm. It should take 4 hrs 20 mins for the medication to be infused. At what time will it be finished?

	Hours	Mins
	7	58
+	4	20
	11	78

As 78 minutes exceeds 60, it can be changed to 1 hour 18 mins giving the answer 12:18am the next day

Example: A nurse gives a patient a painkiller at 8:32am. At 2.12pm the patient complains that the pain has return and the nurse administers another painkiller to the patient. How long did the original painkiller last?

This calculation is made easier if both times are expressed in 24 hr time. The two times become 0832 and 1412.

	Hours	Mins
	14	12
-	8	32

12 minutes take 32 minutes cannot be done, so borrow an hour and payback as 60 minutes

The question becomes

	Hours	Mins
	13	72
-	8	32
	5	40

Example: Seven painters complete a job in 4 hrs 16 minutes, how long was spent completing the job?

	Hours	Mins
	4	16
x		7
	28	112

As 112 minutes exceeds 60, it can be changed to 1 hour 52 mins giving a total of 29 hrs 52 mins.

Example: A teacher takes lessons of 2 hour duration. There are 17 students in the group. How much time (on average) does the teacher spend with each student?

The first step is to change the large unit of time, hours, into a smaller unit, minutes, to make the division easier to perform. Changing 2 hours to minutes gives 2 x 60 = 120 minutes. The time per student is then 120 ÷ 17 = 7.058823529 minutes using a calculator.

This answer would be best expressed in minutes and seconds. The 0.058823529 of a minute becomes 0.058823529 of 60 seconds which is 3.5294… which rounds to 4 seconds. The answer is each student will receive approximately 7 minutes 4 seconds of time from the teacher.

Video ‘Operations with Time’

Activity

1. (a) Change 420 minutes to hours
   (b) Change 330 minutes to hours and minutes.
   (c) Change 215 minutes to hours and minutes.
   (d) Change 191 seconds to minutes (as a decimal).
   (e) Change 54 hours to days and hours.
   (f) Change 324 mins to hrs (as a decimal)

2. (a) Change 2 hours 12 minutes to minutes.
   (b) Change 4.3 hours to hours and minutes.
   (c) Change 4.3 hours to minutes.
   (d) Change 5 hours 38 minutes to hours.
   (e) Change 3 hours 47 minutes to minutes.
   (f) Change 2.68 hours to hours and minutes.

3. Change these am/pm times to 24 hour times

(a)	Midnight	(b)	7:31am
(c)	Midday	(d)	7.31pm

4. Change these 24 hour times to am/pm times

(a)	0047	(b)	0931
(c)	1550	(d)	2300

5. A train leaves at 1227 and arrives at its destination at 2309. How long did the journey take?

6. Three drivers recorded their times to travel to the same holiday destination. The times were 5 hrs 11 mins, 5 hrs 52 mins and 6 hrs 9 mins. What was the average driving time?

7. A car travelling at an average speed of 85 km/hr takes how long to cover 400km?

8. Students at a local school attend six, fifty minute lessons each day. How long have they spent in class over a 5 day school week.

9. A family needs to travel 575 km to reach their holiday destination. If they leave at 6.45am and travel at an average speed of 85 km/hr, what time will they arrive at their destination?

10. A cyclist left home at 5.45 am and arrived at her destination 42 km away at 7:12 am. What was her average speed?

Answers to activity questions

Check your skills

1. (a) The SI unit for length is metres, for mass; kilograms and for time; seconds.
   (b) m is for milli – one thousandth and M is for Mega – one million (Quite different!)

		Traditional Method		Dimensional Analysis Method
2,3	(a)	1000 mm = 1 m means ÷ 1000 495 mm ÷ 1000 = 0.495 m	(a)	$495\,\cancel{mm} \times \frac{1m}{1000\,\cancel{mm}}$ $= 0.495m$
	(b)	1 kg = 1000 g means x 1000 1.395 kg x 1000 = 1 395 g	(b)	$1.395\,\cancel{kg} \times \frac{1000g}{1\,\cancel{kg}}$ $= 1395g$
	(c)	1000 g = 1 kg means ÷ 1000 58 g ÷ 1000 = 0.058 kg	(c)	$58\,\cancel{g} \times \frac{1kg}{1000\,\cancel{g}}$ $= 0.058kg$
	(d)	1 km = 1 000 m means x 1000 1m = 1 000mm means x 1000 0.06 km x 1000000 = 60 000mm	(d)	$0.06\,\cancel{km} \times \frac{1000\,\cancel{m}}{1\,\cancel{km}} \times \frac{1000mm}{1\,\cancel{m}}$ $= 60000mm$
	(e)	10 000 m^2 = 1 ha means ÷ 10 000 25 000 m^2 ÷ 10 000 = 2.5 ha	(e)	$25000\,\cancel{m^2} \times \frac{1ha}{10000\,\cancel{m^2}}$ $= 2.5ha$
	(f)	1 m^3 = 1 kL 3.5 m^3= 3.5 kL 1 kL = 1000 L means x 1000 3.5 kL x 1000 = 3 500 L	(f)	$3.5\,\cancel{m^3} \times \frac{1\,\cancel{kL}}{1\,\cancel{m^3}} \times \frac{1000L}{1\,\cancel{kL}}$ $= 3500L$

4. (a) 1440 in 24 hour time is 2.40pm
   (b) 2:47pm + 1 hr 45mins = 3hrs 92mins or 4:32pm
   (c) 3.15 hours: 0.15 hr = 0.15 x 60mins = 9 mins: 3 hours 9 mins

Conversions – traditional method

		Suitable Unit
1.		
(a)	The length of the Bruxner Highway	km
(b)	The floor area of a house	m^2
(c)	The mass of a newly born chicken	g
(d)	The volume of water in a water storage dam supplying a city.	ML possibly GL
(e)	The length of wood-screws	mm

2. Change the following length measurements to the units shown in brackets

(a)	3.6m (cm)	1m = 100 cm means x 100 3.6 m x 100 = 360 cm
(b)	4500m (km)	1000m = 1 km means ÷ 1000 4500m ÷ 1000 = 4.5km
(c)	55m (km)	1000m = 1 km means ÷ 1000 55m ÷ 1000 =0.055km
(d)	0.325km (mm)	1km = 1000m means x 1000 1 m =1000mm means x 1000 0.325km x 1000000= 325000mm
(e)	4 550 000mm (km)	1000 mm = 1 m means ÷ 1000 1000m = 1 km means ÷ 1000 4 550 000mm÷1 000 000= 4.55km
(f)	5.2 cm (km)	100cm = 1 m means ÷ 100 1000m = 1 km means ÷ 1000 5.2cm ÷ 100 000= 0.000052km

3. Change the following mass measurements to the units shown in brackets

(a)	8550 kg (t)	1000kg=1t means ÷ 1000 8550kg ÷ 1000 = 8.55t

(b)	0.52g (mg)	1 g = 1000 mg means x 1000 0.52g x 1000 = 520mg
(c)	9.1mg (mcg or μg)	1mg = 1000mcg means x 1000 9.1mg x 1000 = 9100mcg
(d)	1.25 g (kg)	1000g = 1kg means ÷ 1000 1.25g ÷ 1000 = 0.00125kg
(e)	2 905 mg (kg)	1000mg = 1g means ÷ 1000 1000g = 1kg means ÷ 1000 2905mg ÷ 1000000 = 0.002905 kg
(f)	35mg (g)	1000mg = 1g means ÷ 1000 35mg ÷ 1000 = 0.035g

4.	Change the following capacity measurements to the units shown in brackets	
(a)	8500mL (L)	1000 mL = 1L means ÷ 1000 8500mL ÷ 1000 = 8.5L
(b)	0.451kL (L)	1 kL = 1000 L means x 1000 0.451kL x 1000 = 451 L
(c)	85.9L (kL)	1000 L = 1 kL means ÷ 1000 85.9 L ÷ 1000 = 0.0859 kL
(d)	1.6 ML (L)	1 ML = 1 000 000 L means x 1 000 000 1.6 ML x 1 000 000 = 1 600 000L
(e)	75L (kL)	1000 L = 1 kL means ÷ 1000 75L ÷ 1000 = 0.075kL
(f)	0.000 6kL (L)	1kL = 1000L means x 1000 0.000 6 kL x 1000 = 0.6 kL

5.	Change the following area measurements to the units shown in brackets	
(a)	25 000m^2 (ha)	10 000m^2 = 1 ha means ÷ 10 000 25 000m^2÷ 10 000 = 2.5 ha
(b)	0.595km^2 (m^2)	1 km^2= 1 000 000 m^2 means x 1 000 000

		$0.595 km^2$ x 1 000 000 = 595 000 m^2
(c)	$26cm^2$ (m^2)	10 000 cm^2 = 1 m^2 means ÷ 10 000 $26cm^2$ ÷ 10 000 = 0.0026 m^2
(d)	31.8ha (km^2)	100 ha = 1km^2 means ÷ 100 31.8 ha ÷ 100 = 0.318 km^2
(e)	450 000m^2 (ha and km^2)	10 000 m^2 = 1 ha means ÷ 10 000 450 000m^2 ÷ 10 000 = 45 ha
(f)	575 212cm^2 (m^2)	10 000 cm^2 = 1 m^2 means ÷ 10 000 575 212cm^2 ÷ 10 000 = 57.5212 m^2

6. Change the following volume measurements to the units shown in brackets

(a)	356 000cm^3 (m^3)	1 000 000 cm^3 = 1m^3 means ÷ 1 000 000 356 000cm^3 = 0.356 m^3
(b)	2.575 m^3 (cm^3)	1m^3 =1 000 000 cm^3 means x 1 000 000 2.575 m^3 = 2 575 000 cm^3
(c)	0.000 4 km^3 (m^3)	1km^3 =1 000 000 000 m^3 means x 1 000 000 000 0.000 4 km^3 x 1 000 000 000 = 400 000 m^3
(d)	375 cm^3 (m^3)	1 000 000 cm^3 = 1m^3 means ÷ 1 000 000 375 cm^3 = 0.000 375 m^3

7. Change the following volume units to the capacity units shown in brackets

(a)	345 cm^3 (mL)	1 cm^3 = 1 mL 345 cm^3 = 345 mL
(b)	0.072 m^3 (L)	1 m^3= 1 kL = 1000 L means x 1000 0.072 m^3 x 1000 = 72 L
(c)	5.5m^3 (L)	1 m^3= 1 kL = 1000 L means x 1000 5.5m^3 = 5500 L
(d)	67 500 cm^3 (kL)	1 cm^3 = 1 mL 1000 mL= 1 L means ÷ 1 000 1000 L = 1 kL means ÷ 1 000 67 500 cm^3 ÷ 1 000 000 = 0.0675 (kL)

Conversions – dimensional analysis

1. Change the following measurements using the dimensional analysis method to the units shown in brackets

(a)	3.55m (cm)	$3.55\cancel{m}\times\frac{100cm}{1\cancel{m}}$ $=355cm$
(b)	6510g (kg)	$6510\cancel{g}\times\frac{1kg}{1000\cancel{g}}$ $=6.51kg$
(c)	55cm (m)	$55\cancel{cm}\times\frac{1m}{100\cancel{cm}}$ $=0.55m$
(d)	1.36 kg (mg)	$1.36\cancel{kg}\times\frac{1000\cancel{g}}{1\cancel{kg}}\times\frac{1000mg}{1\cancel{g}}$ $=1360\,000mg$
(e)	4 550 mm^2 (cm^2)	$4550\cancel{mm^2}\times\frac{1cm^2}{100\cancel{mm^2}}$ $=45.5cm^2$
(f)	5.2 L (mL)	$5.2L\times\frac{1000mL}{1L}$ $=5200mL$
(g)	11.4 mg (g)	$11.4\cancel{mg}\times\frac{1g}{1000\cancel{mg}}$ $=0.0114g$
(h)	305 000cm^3 (m^3)	$305000\cancel{cm^3}\times\frac{1m^3}{1000\,000\cancel{cm^3}}$ $=0.305m^3$
(i)	8 550 g (t)	$8550\cancel{g}\times\frac{1\cancel{kg}}{1000\cancel{g}}\times\frac{1t}{1000\cancel{kg}}$ $=0.00855t$
(j)	240 000m^2 (ha)	$240000m^2\times\frac{1ha}{10000m^2}$ $=24ha$
(k)	9.352L (mL)	$9.352\cancel{L}\times\frac{1000mL}{1\cancel{L}}$ $=9352mL$
(l)	21.8ha (m^2)	$21.8\cancel{ha}\times\frac{10000m^2}{1\cancel{ha}}$ $=218\,000m^2$
(m)	2 905 µg (g)	$2905\cancel{\mu g}\times\frac{1g}{1000\,000\cancel{\mu g}}$ $=0.002\,905g$

(n)	15 305mg (kg)	$15305\,\cancel{mg} \times \frac{1\,\cancel{g}}{1000\,\cancel{mg}} \times \frac{1kg}{1000\,\cancel{g}}$ $= 0.015305kg$

2. Change the following metric rates to the rate shown in brackets

(a)	850mL/hr (L/hr)	$\frac{850\,\cancel{mL}}{1hr} \times \frac{1L}{1000\,\cancel{mL}}$ $= 0.85L/hr$
(b)	4.51L/min (L/hr)	$\frac{4.51L}{1\,\cancel{\min}} \times \frac{60\,\cancel{\min}}{1hr}$ $= 270.6L/hr$
(c)	85.9km/hr (m/min)	$\frac{85.9\,\cancel{km}}{1\,\cancel{hr}} \times \frac{1000m}{1\,\cancel{km}} \times \frac{1\,\cancel{hr}}{60\min}$ $= 1431m/\min$
(d)	1.6 m^2/hr (cm^2/sec)	$\frac{1.6\,\cancel{m^2}}{1\,\cancel{hr}} \times \frac{10\,000cm^2}{1\,\cancel{m^2}} \times \frac{1\,\cancel{hr}}{60\,\cancel{\min}} \times \frac{1\,\cancel{\min}}{60\sec}$ $= 4.4\overline{4}cm^2/\sec$
(e)	75 mg/min (g/hr)	$\frac{75\,\cancel{mg}}{1\,\cancel{\min}} \times \frac{1g}{1000\,\cancel{mg}} \times \frac{60\,\cancel{\min}}{1hr}$ $= 4.5g/hr$
(f)	0.000 6 cm^3/sec (L/hr)	$\frac{0.0006\,\cancel{cm^3}}{1\,\cancel{\sec}} \times \frac{1L}{1000\,\cancel{cm^3}} \times \frac{60\,\cancel{\sec}}{1\,\cancel{\min}} \times \frac{60\,\cancel{\min}}{1hr}$ $= 0.00216L/hr$

3. Change the following metric and imperial units to the units shown, given the conversion.

(a)	Change 25 ha to acres given that 1 hectare is 2.48 acres $25\,\cancel{ha} \times \frac{2.48acres}{1\,\cancel{ha}}$ $= 62acres$	
(b)	Change 100 cm to inches given that 1 inch is 2.54 cm $100\,\cancel{cm} \times \frac{1in}{2.54\,\cancel{cm}}$ $= 39.37in$	
(c)	Change 50 lbs (pounds weight) to kg given that 1 kg is 2.2 lbs $50\,\cancel{lbs} \times \frac{1kg}{2.2\,\cancel{lbs}}$ $= 22.73kg$	
(d)	Change 100 miles to km given that 1 mile is 1.61 km	

$$100\,\cancel{miles}\times\frac{1.61km}{1\,\cancel{mile}}$$
$$=161km$$

(e) Change 36.5 oz (ounces weight) to g given that 1 oz is 28.35g

$$36.5\,\cancel{oz}\times\frac{28.35g}{1\,\cancel{oz}}$$
$$=1034.775g$$

(f) Change 100 metres to yards (yd) given that 1 m is 1.09yd

$$100\,\cancel{m}\times\frac{1.09yd}{1\,\cancel{m}}$$
$$=109yd$$

(g) Change 308cubic inches (in^3) to cm^3 given that 1 in is 2.54 cm

$$308in^3\times\left(\frac{2.54cm}{1in}\right)^3$$
$$=3.08\times16.387$$
$$=5047cm^3$$

4. Change the following rates to the new rate using both imperial and metric units, given the conversion.

(a) Change 3.45 mi/hr to km/hr given that 1 mile is 1.61 km

$$\frac{3.45\,\cancel{mi}}{1hr}\times\frac{1.61km}{1\,\cancel{mi}}$$
$$=5.5545km/hr$$

(b) Change 50.9 m^2/hr to yd^2/hr given that 1 m is 1.09yd

$$\frac{50.9m^2}{1hr}\times\left(\frac{1.09yd}{1m}\right)^2$$
$$=\frac{50.9\,\cancel{m^2}}{1hr}\times\frac{1.1881yd^2}{1\,\cancel{m^2}}$$
$$=60.5yd^2/hr$$

(c) Change 6.45 gal/hr to L/min given that 1 imp. gallon is 4.55 litres

$$\frac{6.45\,\cancel{gal}}{1hr}\times\frac{4.55L}{1\,\cancel{gal}}\times\frac{1hr}{60\min}$$
$$=0.489L/\min$$

(d) Change 3.45 ft^2/hr to cm^2/sec given that 1 ft (foot) is 30.48 cm

$$\frac{3.45ft^2}{1hr}\times\left(\frac{30.48cm}{1ft}\right)^2\times\frac{1hr}{60\min}\times\frac{1\min}{60\sec}$$
$$=\frac{3.45\,\cancel{ft^2}}{1\,\cancel{hr}}\times\frac{929.03cm^2}{1\,\cancel{ft^2}}\times\frac{1\,\cancel{hr}}{60\,\cancel{\min}}\times\frac{1\,\cancel{\min}}{60\sec}$$
$$=0.89cm^2/\sec$$

Time

1.	(a)	Change 420 minutes to hours 60mins =1 hr means ÷ 60 420 min ÷ 60 = 7 hrs
	(b)	Change 330 minutes to hours and minutes. 60mins =1 hr means ÷ 60 330 min ÷ 60 = 5.5hrs = 5hrs 30 mins
	(c)	Change 215 minutes to hours and minutes. 60mins =1 hr means ÷ 60 215 min ÷ 60 = 3.583333 hrs = 3hrs 35 min (0.58333 x 60 = 35)
	(d)	Change 191 seconds to minutes (as a decimal). 60 secs =1 min means ÷ 60 191 secs ÷ 60 = 3.18333 min
	(e)	Change 54 hours to days and hours. 24 hrs = 1 day means ÷ 24 54 hours = 2.25 days = 2days 6 hours (0.25 x 24 = 6)
	(f)	Change 324 mins to hrs (as a decimal) 60mins =1 hr means ÷ 60 324 min ÷ 60 = 5.4 hrs = 5hrs 24 min (0.4 x 60 = 24)

2.	(a)	Change 2 hours 12 minutes to minutes. 1 hr = 60 mins means x 60 2 hours 12 minutes = 2 x 60 + 12 mins = 132 mins
	(b)	Change 4.3 hours to hours and minutes. 4 hours 0.3 x 60 mins = 4 hours 18 mins
	(c)	Change 4.3 hours to minutes. 1 hr = 60 mins means x 60 4.3 hours = 4.3 x 60 mins = 258 mins
	(d)	Change 5 hours 38 minutes to hours. 5 + 38 ÷ 60 hrs = 5.633333 hours
	(e)	Change 3 hours 47 minutes to minutes. 3 x 60 + 47 mins = 227 mins
	(f)	Change 2.68 hours to hours and minutes. 2.68 hrs = 2 hrs 0.68 x 60 mins

2.68 hrs = 2 hrs 41 mins

3.		Change these am/pm times to 24 hour times	
	(a)	Midnight	0000
	(b)	7:31am	0731
	(c)	Midday	1200
	(d)	7.31pm	1931

4.		Change these 24 hour times to am/pm times	
	(a)	0047	12:47am
	(b)	0931	9:31am
	(c)	1550	3:50pm
	(d)	2300	11pm

5. A train leaves at 1227 and arrives at its destination at 2309. How long did the journey take?

	Hours	Minutes	
	23	09	
-	12	27	
Becomes	22	69	Change 1 hr into 60 mins.
-	12	27	
	10	42	The journey took 10hrs 42 mins.

6. Three drivers recorded their times to travel to the same holiday destination. The times were 5 hrs 11 mins, 5 hrs 52 mins and 6 hrs 9 mins. What was the average driving time?

Total of the times is: 17 hours 12 mins or 1032 mins

Average time = 1032 mins ÷ 3 = 344 mins or 5 hrs 44 mins

7. A car travelling at an average speed of 85 km/hr takes how long to cover 400km?

$$\text{speed} = \frac{\text{distance}}{\text{time}}$$

$$85\text{km/hr} = \frac{400\text{km}}{t \text{ hrs}}$$

$$85\text{km/hr} \times t \text{ hrs} = 400\text{km}$$

$$t = \frac{400\text{km}}{85\text{km/hr}}$$

$$t = 4.706\text{hr}$$

Time taken is 4 hrs 42 minutes.

8. Students at a local school attend six, fifty minute lessons each day. How long have they spent in class over a 5 day school week.

Time spent over a week = 6 x 50 x 5 = 1500 min = 25 hours

9.	A family needs to travel 575 km to reach their holiday destination. If they leave at 6.45am and travel at an average speed of 85 km/hr, what time will they arrive at their destination?

$$\text{speed}=\frac{\text{distance}}{\text{time}}$$
$$85\text{km/hr}=\frac{575\text{km}}{t\ \text{hrs}}$$
$$85\text{km/hr}\times t\ \text{hrs}=575\text{km}$$
$$t=\frac{575\text{km}}{85\text{km/hr}}$$
$$t=6.765\text{hr}$$

The journey takes 6 hrs 46mins, the family arrive at 1331 or 1:31pm

10.	A cyclist left home at 5.45 am and arrived at her destination 42 km away at 7:12 am. What was her average speed?

Time taken is 1 hr 27 min, or 1.45 hr (as a decimal)

Average speed is

$$s=\frac{d}{t}$$
$$s=\frac{42km}{1.45hr}$$
$$s\approx 29km/hr$$