GCSE Maths – Ratio, Proportion and Rates of Change

Standard and Compound Units

Notes

WORKSHEET

Standard and Compound Units

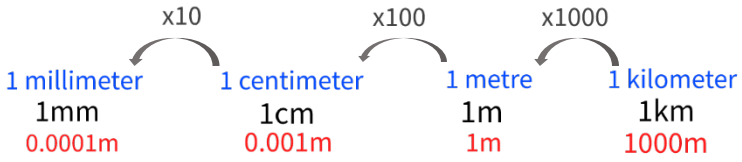
Standard Units

International System of Measure, **SI units**, are the standardised measures used across the world for length, mass and time.

British **Imperial** Measures are different units which are also used to measure quantities. They are still in use today.

	Length	Mass	Time
SI unit	metre	kilogram	second
British Imperial Measures	inches, feet, yards, miles	ounces, pounds, stones, tons	second

Length



Example: Convert 1.8 m into cm

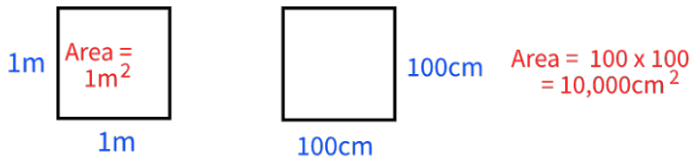
We know 1 m = 100 cm or equivalently 0.01 m = 1 cm.
To convert metres into centimetres, multiply by 100.
To convert centimetres into metres, divide by 100.

$$1.8 \times 100 = 180\ cm$$

Example: Convert 1 m^2 into cm^2

We know 1 m = 100 cm. However, we cannot simply multiply 1 m^2 by 100 because we are dealing with area rather than length.

We can explain this using the area of a square:

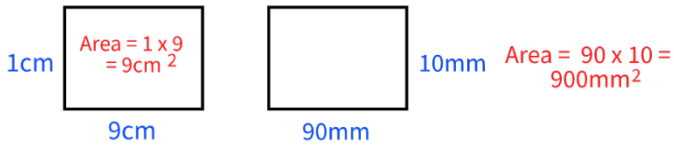


$$1\ m^2 = 10000\ cm^2$$

Example: Convert $9\ cm^2$ into mm^2

We know 1 cm = 10 mm. However, we cannot simply multiply $9\ cm^2$ by 10 because we are dealing with area rather than length.

To visualise, use the area of a rectangle:



$$1\ cm^2 = 900\ mm^2$$

If imperial units are required, the conversions will be provided by the examiner. However, here are some basic facts that may be useful for practice:

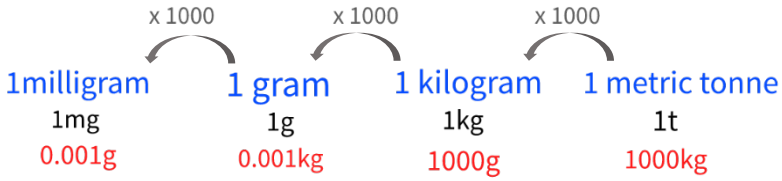
$$12\ inches\ (ins) = 1\ foot\ (ft)$$

$$3\ foot\ (ft) = 1\ yard\ (yd)$$

$$1760\ yards\ (yd) = 1\ mile$$

Mass

The SI unit of mass is the kilogram.



Example: Convert 2.78 kg into grams

We know 1 kg = 1000 g or equivalently 0.001 kg = 1 g.
To convert kilograms into grams, multiply by 1000.
To convert grams into kilograms, divide by 1000.

$$2.78 \times 1000 = 2780g$$

If imperial units for mass are required, they will be provided by the examiner. Some basic facts that are useful for practice and estimation include:

$$16\ ounces\ (oz) = 1\ pound\ (lb)$$

$$14\ pounds\ (lb) = 1\ stone\ (st)$$

$$8\ stone\ (st) = 1\ hundredweight\ (cwt)$$

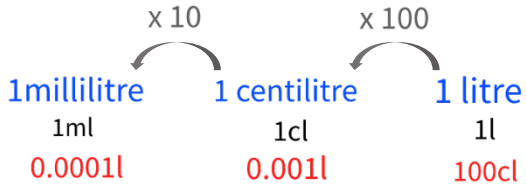
$$1kg \approx 2.2\ pounds$$

Volume and Capacity

Volume is measured in m^3 (SI unit), **capacity** is measured in $litres$ (non-SI unit) and is commonly used to describe volumes of liquid.

$$\begin{aligned} 1\ litre &= 1000\ cm^3 \\ &= 0.001\ m^3 \end{aligned}$$

To help understand this conversion, imagine a $1000\ cm^3$ (or $0.001\ m^3$) container filled with 1 litre of liquid.



Example: Convert 60 millilitres into litres

We know $1\ ml = 0.001\ l$ *or equivalently* $1\ l = 1000\ ml$.
To convert millilitres to litres, divide by 1000.
To convert litres to millilitres, multiply by 1000.

$$60 \div 1000 = 0.06\ l$$

Example: Convert $1.7\ m^3$ into cm^3

We know 1 m = 100 cm, however we need to use volume to convert.

$$1.7\ m^3 = 1\ 700\ 000\ cm^3$$

Example: Convert $8\ m^3$ into ml

1. Convert m^3 ***into*** $litres$.

We know $1\ litre = 0.001\ m^3$ *or equivalently* $1\ m^3 = 1000\ l$.

$$8\ m^3 = 8 \times 1000 = 8000\ l$$

2. Convert litres to millilitres

To convert litres to millilitres, multiply by 1000.

$$8000 \times 1000 = 8\ 000\ 000\ ml$$

Imperial conversions will be given in the exam, however for reference:

$$8\ pints\ (pt)\ =\ 1\ gallon\ (gal)$$

$$1\ litre\ \approx\ 1.75\ pints$$

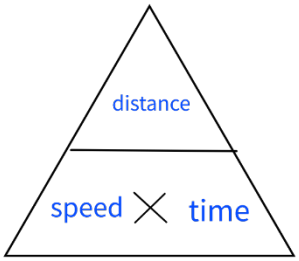
$$1\ gallon\ \approx\ 4.5\ litres$$

Compound Units

Compound units are units that include **two or more unit measures.** Examples are speed, which is expressed as distance per unit of time, and density which is expressed as mass per unit of volume.

Speed

$$Speed\ = \frac{Distance}{Time}$$



To quickly rearrange formulas for each of the three components, use the triangle and cover the component that you would like to find.

For example, to find 'distance', cover the word 'distance' in the triangle to see that $distance = speed\ \times time.$

Remember, it is important to keep the **units constant** when working through a question.

Speed can be expressed as:

$$kilometres\ per\ hour\ (km/h),\qquad metres\ per\ second\ (m/s),\qquad miles\ per\ hour\ (mph)$$

Example: The journey is $120\ km$. Car A travels straight there at $60\ km/h$, Car B travels at $80\ km/h$ but takes a 25 minute break mid-journey. Which car arrives first?

1. Find Car A's journey time

$$time = distance\ \div speed$$
$$time = 120\ km \div 60\ km/h = 2\ hours$$

2. Find Car B's travelling time

$$time = 120\ km \div 80\ km/h = 1.5\ hours = 1\ hour\ 30\ min$$

3. Compare Car B's total journey time

$$1\ hour\ 30\ min\ +\ 25\ min\ break\ =\ 1\ hour\ 55\ min$$

Car B arrives 5 minutes before Car A.

Example: Elaine ran the $100\ m$ race in 10.61 seconds. Shelly ran the race in 10.74 seconds. How many metres/second (m/s) faster was Elaine (2 decimal places)?

1. Find Elaine's speed

$$speed = distance \div time$$
$$speed = 100\ m \div 10.61\ s = 9.425\ m/s$$

2. Find Shelly's speed

$$speed = 100\ m \div 10.74\ s = 9.311\ m/s$$

3. Compare speeds

$$9.425 - 9.311 = 0.114\ m/s$$

Elaine was running $0.11\ m/s$ ***faster than Shelly.***

Example: Keely ran an $800\ m$ race at $25\ km/h$. Jemma ran at $6.8\ m/s$. Who won the race?

1. Put both speeds in the same units

Convert Keely's speed into m/s.

We know $1\ km = 1000\ m$ *and* $1\ hour = 60 \times 60 = 3600\ s.$

$$25\ km\ in\ 1\ hour$$
$$25000\ m\ in\ 1\ hour$$
$$25000\ m\ in\ 3600\ seconds$$

$$25\ km/h = 25000\ m \div 3600\ s = 6.94\ m/s$$

2. Compare

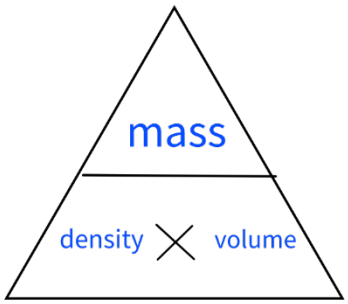
Keely ran at $6.94\ m/s$ *and Jemma ran at* $6.8\ m/s.$

Keely ran faster and won the race.

Mass, Density and Volume

Density is the **mass** of an object **per unit volume.**
Again, the triangle can be used to rearrange the formulas.

$$Density = \frac{Mass}{Volume}$$



Density is usually measured in:
kg/m^3 (also expressed as kgm^{-3})
g/cm^3 (also expressed as gcm^{-3})

Materials generally have known densities, and these will be provided in the exam. It is useful to know that $1000\ kg/m^3$ is the **density of water**. Anything that has a lower density than this will float in water.

Example: The density of gold is $19.3\ g/cm^3$, and a gold necklace weighs $15\ g$. What is the volume of gold used to make the necklace?

1. Identify the formula

On the triangle, cover 'volume' (as this is the quantity we want to find) to see that:

$$volume = \frac{mass}{density}$$

2. Use the values given to calculate volume

$$Volume = 15\ g \div 19.3\frac{g}{cm^3} = 0.777\ldots cm^3 = 0.78\ cm^3$$

Rates of Pay and Unit Prices

A rate of pay is an **amount paid per unit time**. Examples include:

- £9.80/h (£9.80 per hour)
- $38,000/annum ($38,000 per year)
- £328/week (£328 per week)

Unit prices refer to the **price paid per area/volume/amount** for a good. Examples include:

- 126.9p/litre of petrol
- 30.41p/litre of milk
- £4.02/kg of copper

Example: Dan is paid $£11/h$. How many hours will he have to work to make £1000? Once he has started an hour of work, he must complete that hour.

Dan makes £11 *per hour.*
Divide 1000 *by* 11 *to find how many hours it will take to make* £1000.
$1000 \div 11 = 90.9090\ldots hours$

Since he must work a whole number of hours, round up to ensure he makes £1000.
Dan must work 91 hours to make £1000.

Example: Convert $£5.40/litre$ into $pence/ml$

We know $1\ litre = 1000\ ml$ *and* $£1 = 100\ p$.
$1\ litre$ *costs* £5.40
$1000\ ml$ *costs* £5.40
$1000\ ml$ *costs* $540\ p$
$1\ ml$ *costs* $540/1000 = 0.54\ p$
$£5.40/litre = 0.54\ pence/ml$

Standard and Compound Units - Practice Questions

1. Convert 0.02 kilometres to centimetres

2. Convert 3232 cm^2 to m^2

3. Rosa is having a party. She mixes 4 litres of Apple Juice with 1800 ml of Mango Juice and 500 ml of Orange Juice. What is the total capacity of her drink?

4. Madeleine buys some vegetables. She buys 1.5 kg of potatoes, 400 g of tomatoes, 2390 g of onions and butternut squash weighing 1.1 kg. She carries them with 2 bags. Each bag can hold a mass of up to 2500 g. Will Madeleine be able to carry the vegetables with 2 bags?

5. Ava runs at an average speed of 3.2 m/s. How long would it take her to run 20 miles in minutes.

6. The cylinder has a radius of 3 cm and a height of 8 cm. The density of the cylinder is $1.02\ g/cm^3$. Calculate the mass of the cylinder.

7. Mac is buying flour. He can either buy 6 kg of flour for £5 or 7 kg for £5.80. Which has the lower unit price?

Worked solutions for the practice questions can be found amongst the worked solutions for the corresponding worksheet file.