

GCSE Maths – Geometry and Measures

Units of Measurements

Notes

WORKSHEET



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Units of Measures

A unit is a **type of measurement** and describes a **quantity**. Units can be both **metric** and **imperial**. There are standard units to measure: length, area, volume, capacity, mass, time, and money. Questions may ask or imply to **convert** between different types of units as we may need to measure something bigger or something smaller.

Length

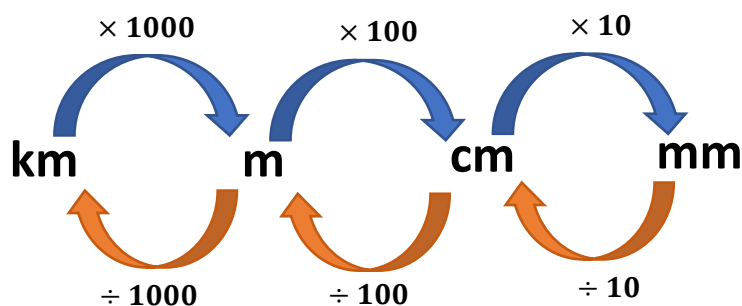
A length measures how **long** something is. Type of length units includes, **centimetres**, **metres**, **kilometres**. A metre is the **standard metric unit** of length.

This diagram shows how to convert between metric length units.

$$10 \text{ mm} = 1 \text{ cm}$$

$$100 \text{ cm} = 1 \text{ m}$$

$$1000 \text{ m} = 1 \text{ km}$$



Example: Convert 3.9 km into millimetres

Use the diagram to work through the length units to convert to millimetres.

First convert from kilometres to metres.

$$3.9 \text{ km} \times 1000 = 3900 \text{ m}$$

Then convert metres to centimetres.

$$3900 \text{ m} \times 100 = 390\,000 \text{ cm}$$

Finally, convert centimetres to millimetres.

$$390\,000 \text{ cm} \times 10 = 3\,900\,000 \text{ mm}$$

So, we have found:

$$3.9 \text{ km} = 3\,900\,000 \text{ mm}$$



Imperial Units of Length

Imperial units are other measures that can be used as units. Imperial units of length include **inch, feet, yard, mile**. Here are some conversion ratios between imperial units that may be given in the question.

$$12 \text{ inch} = 1 \text{ foot}$$

$$3 \text{ feet} = 1 \text{ yard}$$

$$1760 \text{ yards} = 1 \text{ mile}$$

You will also need to **convert** between imperial units and metric units.

$$2.5 \text{ cm} \approx 1 \text{ inch}$$

$$30 \text{ cm} \approx 1 \text{ foot}$$

$$8 \text{ km} \approx 5 \text{ miles}$$

Example: Jenny drives 96 km. Hiten drives 75 miles.
 Jenny says, "I drove a further distance." Is Jenny correct?

- Convert all values so that they are in the same units.

In this question, it makes sense to take all measurements as miles. You could alternatively convert all the measurements into kilometres.

- Use ratios to convert 96 km to miles

$$\times 12 \quad \begin{array}{l} 8 \text{ km} \approx 5 \text{ miles} \\ 96 \text{ km} \approx \dots \text{ miles} \end{array}$$

The equation carried on one side must be applied to the other. Therefore, we must multiply by 12 on the other side.

$$5 \times 12 = 60$$

$$\times 12 \quad \begin{array}{l} 8 \text{ km} \approx 5 \text{ miles} \\ 96 \text{ km} \approx 60 \text{ miles} \end{array} \quad \times 12$$

- Work out who travels the longer distance.

Jenny drives 60 miles and Hiten drives 75 miles.

Since $60 < 75$, Jenny is incorrect, she drives less than Hiten.



Area

Area measures the **size of a surface**. Area units are length measurements squared, such as **mm²**, **cm²**, **m²** and **km²**.

In order to convert between area units, we need to **square** the scale factors of the length conversions.

$$\begin{aligned} (10)^2 \text{ mm}^2 &= 1 \text{ cm}^2 && \rightarrow && \mathbf{100 \text{ mm}^2 = 1 \text{ cm}^2} \\ (100)^2 \text{ cm}^2 &= 1 \text{ m}^2 && \rightarrow && \mathbf{10\,000 \text{ cm}^2 = 1 \text{ m}^2} \\ (1000)^2 \text{ m}^2 &= 1 \text{ km}^2 && \rightarrow && \mathbf{1\,000\,000 \text{ m}^2 = 1 \text{ km}^2} \end{aligned}$$

Another way to explain this conversion is by drawing squares:

Here is a 1 cm by 1 cm square. This could also be written as a 10 mm by 10 mm square.

- The area of this square in cm² is

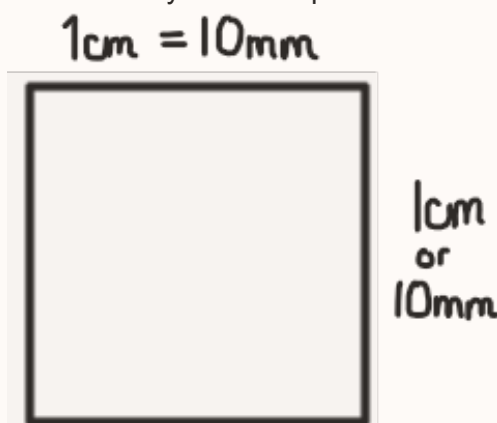
$$1 \times 1 = 1 \text{ cm}^2$$

- The area of this square in mm² is

$$10 \times 10 = 100 \text{ mm}^2.$$

Therefore, the conversion factor for area between cm² and mm² is $100 \div 1 = 100$.

This method also works for m² and km².



Example: Convert 480 mm² into cm²

- Find the conversion from mm² to cm².

$$100 \text{ mm}^2 = 1 \text{ cm}^2$$

$$\text{cm}^2 \rightarrow \div 100 \rightarrow \text{mm}^2$$

- Convert the required value.

$$480 \div 100 = 4.8$$

So,

$$\mathbf{480 \text{ mm}^2 = 4.8 \text{ cm}^2}$$



Volume

Volume measures the **amount of space** in a 3D object. Volume units are length measurements cubed, such as **mm³**, **cm³**, **m³** and **km³**.

To convert between volume units, we need to **cube** the scale factors of the length conversions.

$$(10)^3 \text{ mm}^3 = 1 \text{ cm}^3 \quad \rightarrow \quad \mathbf{1000 \text{ mm}^3 = 1 \text{ cm}^3}$$

$$(100)^3 \text{ cm}^3 = 1 \text{ m}^3 \quad \rightarrow \quad \mathbf{1\,000\,000 \text{ cm}^3 = 1 \text{ m}^3}$$

$$(1000)^3 \text{ m}^3 = 1 \text{ km}^3 \quad \rightarrow \quad \mathbf{1\,000\,000\,000 \text{ m}^3 = 1 \text{ km}^3}$$

Another way to explain this conversion is to consider a cube.

Here is a 1cm-by-1cm-by-1cm cube.

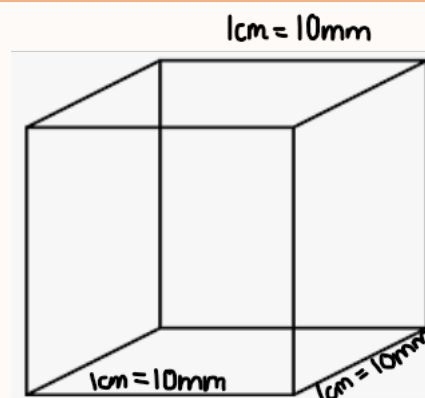
This means it is also a 10 mm x 10 mm x 10 mm cube.

The volume of this cube in cm³ is

$$\mathbf{1 \times 1 \times 1 = 1 \text{ cm}^3.}$$

The volume of this cube in mm³ is

$$\mathbf{10 \times 10 \times 10 = 1000 \text{ mm}^3.}$$



Therefore, the conversion factor for area between cm³ and mm³ is $\mathbf{1000 \div 1 = 1000}$.

This method also works for m³ and km³.

Example: Convert 0.68 cm³ to mm³

1. Find the conversion from mm³ to cm³.

$$\begin{aligned} &1000 \text{ mm}^3 \text{ to } 1 \text{ cm}^3 \\ &1000 \text{ mm}^3 = 1 \text{ cm}^3 \end{aligned}$$

$$\text{cm}^3 \rightarrow \div 1000 \rightarrow \text{mm}^3$$

2. Convert the required value.

$$0.68 \text{ cm}^3 \times 1000 = \mathbf{680 \text{ mm}^3}$$



Capacity

Capacity measures **the amount of liquid something can hold**. It is similar to volume but generally capacity is a unit measure of liquid.

Type of capacity units include **millilitres, centilitres, litres**. A litre is the **standard metric unit** of capacity.

$$10 \text{ ml} = 1 \text{ cl}$$

$$100 \text{ cl} = 1 \text{ l}$$

$$1000 \text{ ml} = 1 \text{ l}$$

Imperial Units of Capacity

Imperial units of capacity include **pints and gallons**. Here are the conversion ratios between imperial units that may be given in the question.

$$8 \text{ pints} = 1 \text{ gallon}$$

You will also need to convert between imperial units and metric units.

$$568 \text{ ml} \approx 1 \text{ pint}$$

$$4.5 \text{ litres} \approx 1 \text{ gallon}$$

Example: Peter buys 3 pints of milk. Alex buys 0.37 gallons of milk. Who buys more milk?

- Convert all values to one, common unit.

We will convert all *values to gallons*. Alternatively, you could choose to convert to pints.

- Use ratios to convert 3 pints to gallons.

$$\times \frac{3}{8} \quad \begin{array}{l} \curvearrowright 8 \text{ pints} = 1 \text{ gallon} \\ \curvearrowright 3 \text{ pints} = \dots \text{ gallons} \end{array}$$

The operation applied on one side must be applied to the other side. Therefore, we must multiply the right-hand side by $\frac{3}{8}$.

$$1 \times \frac{3}{8} = 0.375$$

$$\times \frac{3}{8} \quad \begin{array}{l} \curvearrowright 8 \text{ pints} = 1 \text{ gallon} \\ \curvearrowright 3 \text{ pints} = 0.375 \text{ gallons} \end{array} \quad \times \frac{3}{8}$$

- Conclude who buys more milk.

Peter buys 0.375 gallons and Alex buys 0.37 gallons. Since $0.37 < 0.375$, **Peter buys more milk**.



Capacity and Volume

The terms capacity and volume are interchangeable as the definitions are similar.

By definition,

$$1000 \text{ cm}^3 = 1 \text{ litre.}$$

Example: Convert 500 ml to cm^3

1. Find the conversion between millilitres to litres.

$$1000 \text{ ml} = 1 \text{ litre}$$

$$\text{ml} \rightarrow \div 1000 \rightarrow \text{litres}$$

2. Convert the given value into litres

$$500 \text{ ml} \div 1000 = 0.5 \text{ litres}$$

3. Convert litres to cm^3 by the definition $1000 \text{ cm}^3 = 1 \text{ litre}$.

$$1000 \text{ cm}^3 = 1 \text{ litre}$$

$$500 \text{ cm}^3 = 0.5 \text{ litre.}$$

Therefore, $0.5 \text{ litres} = 500 \text{ cm}^3$.

So, our calculations show that $500 \text{ ml} = 500 \text{ cm}^3$.

Mass

Mass measures the **amount of matter in an object**. Units of mass include **milligrams, grams, kilograms, and tonnes**.

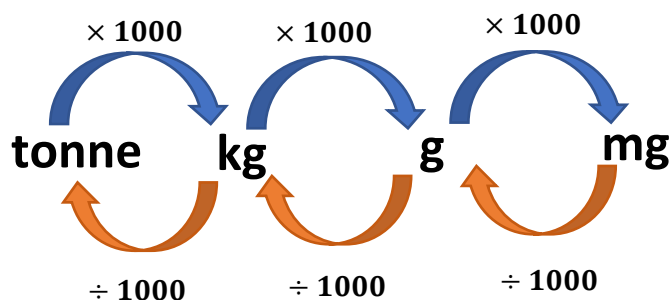
A gram is the **standard metric unit** of mass.

This diagram shows the conversion between capacity units

$$1000 \text{ mg} = 1 \text{ g}$$

$$1000 \text{ g} = 1 \text{ kg}$$

$$1000 \text{ kg} = 1 \text{ tonne}$$



Example: Convert 0.45 tonnes to grams

Use the diagram to work through the mass units to convert to grams.

First convert tonnes to kilograms:

$$0.45 \times 1000 = 450 \text{ kg}$$

Then convert kilograms to grams:

$$450 \text{ kg} \times 1000 = 450\,000 \text{ g}$$

So, we have:

$$\mathbf{0.45 \text{ tonnes} = 450\,000 \text{ g}}$$

Imperial Units of Mass

Imperial units of mass include **ounces**, **pounds**, and **stones**. Here are some conversion ratios between imperial units that may be given in the question.

$$\mathbf{16 \text{ ounces} = 1 \text{ pound}}$$

$$\mathbf{14 \text{ pounds} = 1 \text{ stone}}$$

You will also need to convert between imperial units and metric units using the following approximations:

$$\mathbf{28 \text{ g} \approx 1 \text{ ounce}}$$

$$\mathbf{2.2 \text{ pounds} \approx 1 \text{ kg}}$$

$$\mathbf{6.4 \text{ kg} \approx 1 \text{ stone}}$$

Example: Deepthi buys 3 ounces of tomatoes. Hana buys 8 tomatoes each weighing 10g. Who bought more tomatoes by mass?

1. Calculate the mass of tomatoes Hana buys in grams.

$$8 \times 10 \text{ g} = 80 \text{ g}$$

2. Convert all values to one, common unit. Here, we will convert all values to grams.

$$\begin{array}{l} \times 3 \quad \curvearrowright \quad 1 \text{ ounce} = 28 \text{ g} \\ \quad \quad \quad \quad \quad 3 \text{ ounces} = \dots \text{ grams} \end{array}$$

The operation applied to one side must be applied to the other. Since $28 \times 3 = 84$, we have

$$1 \text{ ounce} = 28 \text{ g}$$

$$3 \text{ ounces} = 84 \text{ grams}$$

3. Work out who buys more tomatoes.

Deepthi buys 84 g of tomatoes. Hana only buys 80 g. Therefore, Deepthi buys more tomatoes in mass.



Time

Time can be measured in various units including **milliseconds**, **seconds**, **minutes**, **hours**, **days** and **weeks**.

In questions, the **most common** conversions are between **seconds**, **minutes**, and **hours**. However, it is useful to know other time conversions.

$$1000 \text{ milliseconds} = 1 \text{ second}$$

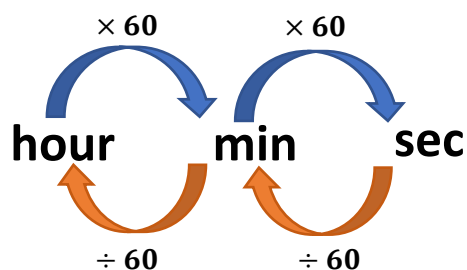
$$60 \text{ second} = 1 \text{ min}$$

$$60 \text{ min} = 1 \text{ hour}$$

$$24 \text{ hours} = 1 \text{ day}$$

$$7 \text{ days} = 1 \text{ week}$$

$$60 \text{ min} = 1 \text{ hour}$$



Example: Convert 2 days into minutes

Use the diagram to work through the time units to convert to hours.

1. Convert days to hours.

There are 24 hours in a day. Therefore, there are $2 \times 24 = 48$ hours in 2 days.

2. Convert hours to minutes.

$$48 \text{ hours} \times 60 = 2880 \text{ minutes}$$

Therefore,

$$\mathbf{2 \text{ days} = 2880 \text{ minutes.}}$$



Money

Money is measured in **pounds (£)** or **pence (p)**.

$$100 \text{ p} = \pounds 1$$

However, in **different countries** money has different units. For example, in Germany, money is measured in euros (€) and in the USA money is measured in dollars (\$).

To convert between different currencies, questions will give an **exchange rate**.

Example: Khushi goes to a shop and buys bread costing 79p, milk costing £1.03, chocolate costing 34p and biscuits costing £1.45. What is the total cost of her shop in pounds?

1. Convert all the prices to 1 unit.

We convert all units into pounds:

$$79\text{p} = \pounds 0.79$$

$$34\text{p} = \pounds 0.34$$

2. Add up all the prices now they are in the same unit.

$$0.79 + 0.34 + 1.03 + 1.45 = \pounds 3.61$$

Khushi's total shop costs £3.61

Example: Aadya is going on holiday to India. She has £420 that needs to be converted to rupees before she goes. How many rupees will she receive if the exchange rate is £1 = 102 rupees?

1. Use ratios to convert £420 to rupees.

$$\begin{aligned} \times 420 & \quad \curvearrowleft \quad \begin{aligned} \pounds 1 &= 102 \text{ rupees} \\ \pounds 420 &= \dots \text{ rupees} \end{aligned} \end{aligned}$$

The operation applied on one side must be applied to the other side. Therefore, we must multiply the right-hand side by 420:

$$102 \text{ rupees} \times 420 = 42840$$

$$\begin{aligned} \times 420 & \quad \curvearrowleft \quad \begin{aligned} \pounds 1 &= 102 \text{ rupees} \\ \pounds 420 &= 42840 \text{ rupees} \end{aligned} \quad \curvearrowright \times 420 \end{aligned}$$

Aadya will receive 42840 rupees for £420.



Units of Measures – Practice Questions

1. Rachel and Phoebe go running. Rachel runs 1 km to Phoebe's house and together they run 5 miles. Rachel then runs back home.
How many kilometres does Rachel run?
2. The volume of a box is 3000000 cm^3 . What is the volume in m^3 ?
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. Convert 3 stones to grams using the conversion $6.4 \text{ kg} = 1 \text{ stone}$.
5. Madeleine buys some vegetables. She buys 1.5 kg of potatoes, 400 g of tomatoes, 2390 grams of onions and a butternut squash weighing 1.1 kg. She carries them with 2 bags. Each bag can hold a mass of up to 2500 grams. Will Madeleine be able to carry the vegetables with two bags?
6. Covert 2,160,000 seconds to hours.
7. Ava is travelling on a train to Brooklyn. She leaves at 11:05. Her journey takes 1 hour and 57 minutes. What time is her train due to arrive in Brooklyn?
8. Keith is going on holiday to Japan. He wants to change £150 into yen. The exchange rate is $\text{£}1 = \text{¥}168$. How many Yen will Keith receive?
9. Marcus buys 2 pens at 64p each, 3 binders at £1.09 each and 1 rubber at £1.19. He pays with a £10 note. Work out how much change Marcus should get from £10.

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

